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TECHNICAL SUPPORT DOCUMENT FOR PROPOSED TRANSPORTATION CONTROL STRATEGY FOR THE WASATCH FRONT INTRASTATE AQCR

GCA Corporation

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Technical Support Document

FOR

PROPOSED TRANSPORTATION CONTROL STRATEGY FOR THE WASATCH FRONT INTRASTATE AQCR

ENVIRONMENTAL PROTECTION AGENCY

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TECHNICAL SUPPORT DOCUMENT

for

PROPOSED TRANSPORTATION CONTROL STRATEGY FOR THE WASATCH FRONT INTRASTATE AQCR

Prepared by:

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GCA TECHNOLOGY DIVISION
Bedford, Massachusetts

Contract No. 68-02-0041

ENVIRONMENTAL PROTECTION AGENCY
Research Triangle Park
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June 1973

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I. INTRODUCTION AND SUMMARY

This document presents technical discussion and analysis relative to the proposed Transportation Control Plan for the Wasatch Front Intrastate Air Quality Control Region (AQCR). The Transportation Control Plan sets forth those control measures that are required beyond the federal motor vehicle emission control program in order to meet the national ambient air quality standards for carbon monoxide.

The necessity for such a plan was formalized on May 31, 1972. On that date the EPA Administrator, in approving state implementation plans, advised the Governor of Utah that in order to complete the requirements of sections 51.11 (b) and 51.14 of the Clean Air Act, a transportation and/or land use control plan for the Wasatch Front AQCR was to be submitted to the Administrator by February 15, 1973. Since no state had experience with such control measures, the Administrator, in setting the new date for submission of such plans, also extended the deadline for meeting the air quality standards from 1975 to 1977.

EPA provided assistance to Utah, and a number of other states, in preparing such plans through contractual arrangements with GCA Corporation and other firms. In the case of Utah, GCA Corporation conducted a study of the problem in the urban Salt Lake City area, in close cooperation with EPA and the various agencies of the state, and prepared a report suggesting an appropriate control plan (Ref. 1).

On January 31, 1973, the United States Court of Appeals for the District of Columbia Circuit found that the Administrator did not conform to the strict requirements of the Clean Air Act of 1970 in permitting states to delay submission of transportation control portions

of their implementation plans until February 15, 1973, and in granting them extensions until mid-1977 for attainment of the national primary ambient air standard without following the procedures established in Section 110 (3) 42 U.S.C. 1857 c-5 (e). Accordingly, the court ordered that the Administrator rescind the extension granted the states for implementation plans. The affected states were required to submit a control plan by April 15, 1973. In the case of Utah, the plan was to show attainment of the national ambient air quality standards for carbon monoxide as expeditiously as possible, but no later than May 31, 1975.

Following this ruling, it was decided that because of the rapidly-expanding knowledge and experience gained by EPA, GCA Corporation, and other parties involved in the initial study, a new study should be undertaken directed toward meeting the May 31, 1975 deadline. It was also decided that Ogden and Provo should be included in the new study because of high concentrations occassionally observed in these two cities. This expanded study, which incorporated new high altitude emission factors and the effect of the Administrator's decision to relax emission standards for 1975 vehicles, was undertaken by GCA Corporation, again with the assistance of Wilbur Smith and Associates, Inc.

The State of Utah submitted a proposed implementation plan control strategy on April 17, 1973 which was judged by the Administrator to be inadequate. In the light of the State's failure to submit an acceptable plan, EPA contracted further with GCA to assist with the development of a transportation control plan that could be promulgated by the Administrator. The resulting plan, to which this document is related, incorporates the modifications necessary to attain the air quality standards by May 31, 1975, rather than 1977, and it also makes use of new information in the area of control measures for in-use vehicles that has been developed since the preceding studies. Although the plan is prepared in the form of an EPA promulgation, it remains the intent of EPA to approve, insofar as possible, any proposals made by the State and to make every effort to meet the special needs of the area and to incorporate the expressed wishes of its citizens.

This plan is specifically directed toward achieving the 8-hour carbon monoxide standard of 9 ppm. During the period from 1970 through 1972, this standard has been substantially exceeded in Salt Lake City, Ogden, and Provo, the three principal cities along the heavily populated Wasatch Front. The proposed transportation control plan is designed to reduce the emissions of carbon monoxide expected within the central business districts of the three cities on May 31, 1975 by the following amounts: Salt Lake City, 54 percent; Ogden, 46 percent; and Provo, 51 percent. These additional reductions beyond the normal decrease caused by the federal motor vehicle emission control program (FMVCP) will be

achieved principally by reducing the amount of pollution emitted by individual light-duty vehicles during use, and in part by reducing the total amount of vehicle usage within the central business districts of the cities.

The control measures designed to reduce the emissions from each vehicle include a program of vehicle inspection and maintenance, the installation of an intake manifold air bleed device on pre-1968 light duty vehicles, and the installation of an approved high altitude modification device on 1968-1974 light duty vehicles. Emissions per vehicle mile of travel (VMT) will also be reduced in Salt Lake City and Provo by improvements in traffic flow. For reductions in VMT within the central business districts, the plan utilizes strategies proposed by the State. These include increased use of mass transit in all three cities and parking prohibitions during peak hours in downtown Salt Lake City. Some reduction in VMT within downtown Ogden is expected to result from the completion of the by-pass south of the city center from I-80N to I-15.

This report is in two parts. The main body of the report presents the rationale used in developing the Transportation Control Plan, and the Appendices present supporting data and methodology.

Recent estimates, made since the completion of this report, indicate that an adequate supply of the two retrofit devices may not be available in time to complete their installation before June 30, 1976. EPA is, consequently proposing three additional measures to reduce emissions that can be implemented by the May 31, 1975 deadline. These

three measures are: (1) a limitation on gasoline sales, (2) the use of bus/carpool traffic lanes, and (3) the management of the supply of new parking spaces. These additional control measures are discussed in Appendix E, but estimates of the impact of these measures have not been incorporated into this report.

II. VERIFICATION AND ASSESSMENT OF THE CARBON MONOXIDE PROBLEM

A. OUTLINE OF METHODOLOGY

The carbon monoxide problem in the Wasatch Front AQCR was assessed by comparing recent air quality data in Salt Lake City, Ogden, and Provo with the national standards. Observations for the years 1970-1972 showed that the 8-hour standard was exceeded in each of the three cities. The method used to calculate the reduction required to lower future ambient concentrations to allowable levels was the so-called proportional model, which assumes a linear relationship between emissions and ambient concentrations. For example, if the observed concentrations exceed the standards by a factor of two, the model states that the standards can be met by reducing the emissions by one-half. A more complete discussion of this application of the proportional model and its limitations is contained in the earlier Salt Lake City report (Ref. 1).

The basic procedure employed was to establish an allowable emission level for each city from a vehicle emission estimate and air quality data for a selected reference year. The effectiveness of a candidate transportation control package in achieving the standards in 1975 was then evaluated by comparing projected emissions with this allowable level.

A vehicle emission estimate is the product of two factors: vehicle miles traveled (VMT) and an emission factor or rate. The techniques employed for the determination of VMT, speeds, and vehicle age distributions were presented in Reference (1), and are reviewed in Appendix A. The vehicle emission factors used in this study are

based on measured and projected emission rates for each vehicle class considering age of vehicle, effectiveness of emission controls, average speed, and vehicle age distribution. The impact of Federal new car standards is considered in both the present and projected vehicles. A more complete discussion of the estimation procedure is given by Kircher and Armstrong (Ref. 3).

The equation for calculating emission factors is shown below:

$$e_{np} = \sum_{i=n-12}^{n+1} c_i \cdot d_i \cdot m_1 \cdot s$$

e_{np} = emission factor in grams per vehicle mile for calendar year n and pollutant p

c_i = the 1975 Federal test procedure emission rate (grams/mile) for pollutant p for the i^{th} model year, at low mileage

d_i = the controlled vehicle pollutant p emission deterioration factor for the i^{th} model year at calendar year n

m_i = the weighted annual travel of the i^{th} model year during calendar year in (The determination of this variable involves the use of the vehicle model year distribution.)

s_i = the weighted speed adjustment factor for the i^{th} model year vehicles.

c_i for high altitude cities such as Salt Lake City is based on a recent study of light duty vehicle exhaust emission rates in Denver, Colorado. d_i, the deterioration factor, accounts for the aging or

deterioration of emission control devices. m_i, the weighted annual mileage is determined as follows,

$$mi = \frac{V_i \times D_i}{\Sigma V \times D}$$

V_i = fraction of each model year vehicle in use on December 31 of year

D_i = average miles driven of each model year vehicle

s_i, the speed adjustment factor, varies roughly inversely with average route speed. 1975 and later model years are assumed to have a factor of one.

B. BASELINE AIR QUALITY AND EMISSION LEVELS

1. Background

The Wasatch Front Intrastate AQCR is comprised of Weber, Davis, Salt Lake, Utah, and Tooele counties. The first four of these counties lie just to the west of the Wasatch Mountain Range along the eastern edge of the AQCR and contain the most densely populated areas in the state, which are, consequently, the areas with the greatest volume of vehicular traffic and the highest emissions of carbon monoxide. This densely populated region consists roughly of an 80-mile, north-south zone centered on Salt Lake City and extending from Provo in the south to Ogden in the north. The western half of the Wasatch Front AQCR (Tooele County) is sparsely populated, being dominated by the Great Salt Lake Desert. Approximately 78 percent of

the population of Utah resides in the eastern four counties of the AQCR, and 36 percent of the population of these four counties was distributed in 1970 among the three principal cities as follows: Salt Lake City, 175,885; Ogden, 69,478; and Provo, 53,131.

The cities of Salt Lake, Ogden, and Provo all lie at the eastern edge of the Great Salt Lake Basin and are subject to the same large scale meteorological systems. In addition, the topographical features of the area form a smaller natural basin extending from Salt Lake City to Provo within which locally generated pollutants tend to be confined. This basin is bordered on the east by the Wasatch Mountain Range and on the west by the Oquirrh Mountain Range. Within this basin, Salt Lake City and Provo are separated topographically by a line of low hills. At its northern end the valley opens toward the northwest to the Great Salt Lake. Pollution problems associated with motor-vehicle-generated carbon monoxide become acute during the fall and winter seasons on occasions when the air becomes very stable and the vertical transfer of pollutants is severely restricted and winds are generally light and variable. Typically, these conditions develop during periods when anticyclones become stationary over the region.

Carbon monoxide levels have been monitored since the beginning of 1970 at Salt Lake City and Provo and since February 1971 at Ogden, by the EPA approved non-dispersive infrared method. The monitoring stations are located on convenient rooftops within the central business districts. The locations of the monitoring stations are given in Table II-1.

TABLE II-1

LOCATIONS OF MONITORING STATIONS

CITY	LOCATION OF MONITORS		
	SITE	STREET LOCATION	HT. ABOVE GROUND (m)
Salt Lake City	County Health Bldg.	610 South & 2nd East	10
Ogden	County Health Bldg.	2570 Grant Avenue	5
Provo	Court House	University Avenue near Center Street	15

2. Ambient Carbon Monoxide Levels, 1970 - 1972

Table II-2 gives the highest and second highest 1-hour and 8-hour average carbon monoxide concentrations observed during the three 1-year periods. The percent reductions in carbon monoxide emissions required to meet the national standards, based on linear rollback calculations and the second highest measured concentrations, are shown in parentheses in the table. The amount of transportation control needed in each of the three cities is based on the maximum required reduction indicated in any of the 3 years. It can be seen from Table II-2 that control measures adequate to ensure meeting the 8-hour carbon monoxide standard should automatically ensure meeting the 1-hour standard. For this reason, the additional control measures proposed are evaluated in terms of the reductions in emissions that will be required to meet the 8-hour standard.

The three highest 8-hour carbon monoxide concentrations observed each month of the observation period in each of the three cities are tabulated in Appendix F. A more complete summary of Salt Lake City data is given in Reference 1.

TABLE II-2

HIGHEST AND SECOND HIGHEST CO CONCENTRATIONS OBSERVED WITHIN THE WASATCH FRONT AQCR. NUMBERS IN PARENTHESES INDICATE PERCENT REDUCTION IN CO EMISSIONS REQUIRED TO MEET NATIONAL STANDARDS.

CITY	1-HOUR CO CONCENTRATION (PPM)					
	1970		1971		1972	
	Highest	2nd Highest	Highest	2nd Highest	Highest	2nd Highest
Salt Lake City	39	36 (2.9)	35	35 (0)	61	57 (38.6)
Ogden	-	-	30	27 (0)	65	47 (25.5)
Provo	21	20 (0)	37	36 (2.9)	30	28 (0)

CITY	8-HOUR CO CONCENTRATION* (PPM)					
	1970		1971		1972	
	Highest	2nd Highest	Highest	2nd Highest	Highest	2nd Highest
Salt Lake City	23	22 (59.1)	24	20 (55.0)	41	21 (57.1)
Ogden	-	-	18	17 (47.1)	34	14 (35.7)
Provo	13	9 (0)	21	20 (55.0)	18	16 (43.8)

* 2nd highest concentrations are based on independent 8-hour averages.

NOTE: Concentrations are compared with the national standards of 35 ppm for 1 hour and 9 ppm for 8 hours. These standards are not to be exceeded more than once per year.

3. Carbon Monoxide Emissions

Baseline emission levels have been estimated and summarized to provide a reference that can be used to determine the further reductions that must be effected by transportation control measures. The estimates of motor vehicle emissions have been made using the emission factors and procedures presented in Kircher and Armstrong, "An Interim Report on Motor Vehicle Emission Factors" (Ref. 3). The emission and deterioration factors for 1975 model, light duty vehicles given in this report, however, have since been modified by EPA to take into account the relaxation in emission standards announced by the Administrator on April 11, 1973, and these modified factors for 1975 vehicles have been used in the calculations upon which the transportation control measures are based.

In the previous Salt Lake City study (Ref. 1), traffic density and vehicular emissions were studied in detail throughout the 14-square-mile core area of the city. From these studies, it was determined that the area with the highest carbon monoxide emissions was the central business district (CBD), and that control measures, in addition to the FMVCP, would be needed only in downtown Salt Lake City in 1977. As would be expected, traffic density studies in Ogden and Provo also show that high emissions are confined to the CBD's of these two cities. Consequently, carbon monoxide emission density (i.e., emission rate per square mile) was projected only for these critical areas in developing the requisite transportation control measures.

Table II-3 shows the emission density estimates, based on the ongoing FMVCP, in each of the three cities from the reference year to December 1982. Table II-3 also shows the allowable emission density

TABLE II-3

PROJECTED CARBON MONOXIDE EMISSIONS
WITHOUT TRANSPORTATION CONTROLS

YEAR (as of Dec. 31)	VEHICULAR EMISSIONS (kg/8 hr/mi^2)		
	SALT LAKE CITY	OGDEN	PROVO
1970	10,984*		
1971	11,094	7,160*	6,152*
1972	10,937	7,253	6,131
1973	10,458	7,175	5,983
1974	10,025	7,131	5,826
1975 (May 31)	9,765	7,036	5,697
1975	9,401	6,903	5,518
1976	8,467	6,386	5,095
1977	7,289	5,628	4,495
1978	6,354	5,017	3,944
1979	5,527	4,420	3,471
1980	4,561	3,701	2,928
1981	3,585	2,990	2,375
1982	3,163	2,615	2,074
Allowable	4,493	3,791	2,768

*Indicates base year emissions

for each city calculated by means of the proportional model. In calculating the allowable emission density, it has been assumed that carbon monoxide emissions affecting the CBD's from non-vehicular sources may be neglected. It is apparent from these results that the national standard for carbon monoxide will not be met by May 1975 without additional controls. The percent reduction required each year from additional controls is given in Table II-4.

TABLE II-4

REDUCTION REQUIRED FROM ADDITIONAL CONTROLS

YEAR (as of Dec. 31)	REQUIRED REDUCTION (percent)*		
	SALT LAKE CITY	OGDEN	PROVO
1974	55	47	52
1975 (May 31)	54	46	51
1975	52	45	50
1976	47	41	46
1977	38	33	38
1978	29	24	30
1979	19	14	20
1980	2	0	6
1981	0	0	0
1982	0	0	0

*Reduction required from expected levels (FMVCP only) on indicated date

III. RECOMMENDED CONTROL MEASURES

A. CONTROL ALTERNATIVES IN GENERAL

The emissions of carbon monoxide in the three city centers, come essentially entirely from motor vehicle sources*, so that the reductions required beyond those provided by the federal emission control program will need to be effected by transportation controls that reduce total motor vehicle emissions.

The various transportation control strategies available for effecting the required further emission reduction can be divided for discussion purposes into two groups: those aimed at reducing the total vehicle miles of travel (VMT), and those aimed at reducing the amount of pollutant emitted per vehicle mile.

Over a long period of years, there is no question that the ongoing maintenance of the ambient air quality standards will need to depend primarily on controlling VMT, the amount of vehicle usage; it is not possible, however, to effect sizable region-wide VMT reductions by 1975, since most such measures require longer lead time to develop alternative means of travel. In contrast to this, those strategies that are aimed at reducing the emissions of individual vehicles can only have a major effect in the short run; once the replacement of older, less-controlled, vehicles with 1976 and later models is largely completed, these strategies will have only relatively small effects.

There is a broad variety of transportation control measures designed to exert their effect by reducing the total vehicle miles of travel (VMT). Some of these involve modifying travel patterns, either

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* Major point sources of carbon monoxide in Salt Lake, Utah and Weber counties, and total emission estimates by source category for each county are presented in Appendix G.

temporally or geographically; most of them, however, involve reducing the demand for motor vehicle travel.

As might be expected in a complex urban environment, these various measures are not independent, but are in many cases closely inter-related. Of particular significance is the interaction between those measures, such as gasoline rationing, that operate by restricting vehicle usage, and those, such as improved mass transit service, that operate by positive encouragement of alternatives to vehicle usage. It appears to be generally the case, though based on a limited number of actual test situations, that encouragements to mass transit are not very effective unless accompanied by some restriction on vehicle usage, and, in a similar view, vehicle use restraints are usually not fully effective unless improvements in the alternative (typically mass transit) are also made. Consequently, the selected mix of control measures should consist of the most appropriate and/or effective measures of each category.

Because of the relatively-short period for implementation by May 31, 1975, it is not possible to effect the major portion of the required carbon monoxide reductions from VMT-reducing control measures. Consequently, sizable portions of the reductions need to be achieved by lowering the emissions of individual vehicles, which may be done by providing various emission-control devices on pre-1976 vehicles.

Table III-1 lists typical control measures of the two types discussed above, most of which were considered for possible use in the transportation control plan. A more complete discussion of possible control measures is contained in Appendix B.

TABLE III-1

TYPICAL CONTROL MEASURES

VMT-REDUCING MEASURES

Travel Pattern Modification

- Stagger work hours
- Vehicle-free zones
- Bypass through traffic

Reduce Vehicle Travel Demand

- Improve mass transit service
- Restrict parking
- Shorten work week
- Peripheral parking
- Road pricing
- Gasoline rationing
- Periodic vehicle prohibition
- Increase fuel tax
- Car pooling
- Increase parking fees

VEHICLE-EMISSION-REDUCING MEASURES

Traffic Flow Improvements

- Surveillance and control
- Design and operational improvements
- Truck loading zones
- Driver advisory displays

Source Modification

- Inspection/maintenance program
- Exhaust emission control devices
- Gaseous fuel conversion

B. PROPOSED CONTROLS*

1. General

According to Table II-4, emissions on May 31, 1975, in the three CBD's will need to be reduced by approximately one-half, in addition to the reductions brought about by the FMVECP, if the 8-hour carbon monoxide standard is to be met by that date. As would be expected, the previous study (Ref. 1), and independent estimates by the State of Utah, indicate that reductions of this magnitude cannot be obtained with the required time frame by reduction in VMT without imposing such severe restraints on vehicle usage as to seriously disrupt the economic and social fabric of the communities. Thus, it has been judged necessary to place principal reliance upon an inspection and maintenance program and emission controls. In principal these controls may be either engine modifications to reduce the formation of pollutants in the engine, or tailpipe control devices to remove the pollutants from the exhaust after it leaves the engine. Table III-2 summarizes the effects of various such control measures, as estimated by EPA research and development efforts. Most are applicable to pre-controlled vehicles, that is, vehicles built before any federal exahust emission standards were in effect, although the distinction is not rigid. The only control device applicable to the newest cars is an oxidizing catalytic converter, the last in the list in Table III-2.

Based on considerations of effectiveness, cost, and availability, the following three source-modification control measures are proposed:

* A more detailed discussion of the selected control measures, including documentation for the estimated emission reductions is given in Appendix C.

TABLE III-2

REDUCTION ACHIEVED BY CONTROL DEVICES

Control Device Combination	Average Reduction (%) HC	CO
Lean Idle Air/Fuel Ratio Adjustment and Vacuum Spark Advance Disconnect	25%	9%
Oxidizing Catalytic Converter and Vacuum Spark Advance Disconnect	68%	63%
Air Bleed to Intake Manifold	21%	58%
Exhaust Gas Recirculation and Vacuum Spark Advance Disconnect	12%	31%
Oxidizing Catalytic Converter*	50%	50%

*On vehicles already controlled to meet federal exhaust emission standards.

(1) A semi-annual inspection and maintenance program

(2) An intake manifold air bleed device (ABIM) on pre-1968 light-duty, gasoline-powered vehicles

(3) A high-altitude modification device on 1968-1974 light-duty, gasoline-powered vehicles

In addition to providing the greatest portion of the required reduction within the CBD's, these control measures have the additional advantage of reducing emissions generally throughout the AQCR and thus of relieving possible areas of high concentrations which are as yet undetected.

Emissions per VMT will also be reduced in Salt Lake City by improvements in traffic flow resulting principally from the installation of a computerized signal system, and from parking prohibitions during peak traffic periods. Traffic flow will also be increased in Provo by a change from angle to parallel parking in a congested area. Some reduction in VMT within downtown Ogden is expected to result from the completion of a by-pass from I-80N to I-15. Increased use of mass transit is assumed in all three cities.

2. Effect of Controls

a. Inspection and Maintenance

The recommended inspection/maintenance program involves a semi-annual inspection of emission related vehicle components and an "idle-mode" emissions test, that is, measurement of exhaust emissions while the engine is idling at the manufacturer's recommended engine speed. If the exhaust emissions exceed the designated rejection levels, or if any of the other emission-control devices or modifications have deteriorated or been tampered with, the owner will be required to have corrective maintenance performed and have the vehicle re-inspected.

The inclusion of an inspection and maintenance program among the control measures is a rather obvious choice. It results in a substantial reduction in emissions by itself, and is necessary in order to achieve the maximum effect from the other vehicle-emission controls proposed. It is also one of the socially and institutionally most feasible control measures, largely because of Utah's existing well-established safety inspection program. The most recent EPA research on test methods indicates that acceptable effectiveness can be gained with the simpler "idle-mode" emission test as well as by the "loaded" emission test that requires the use of a dynamometer. Consequently, the less expensive idle-mode testing system is recommended.

The effectiveness of inspection programs has been estimated by EPA, and found to depend on the initial failure rate at the test facility, which of course depends on the stringency of the measurement limits defined as passing the inspection. These effectiveness figures, in Table III-3, are functions of the average distribution of emissions, the amount of pre-inspection maintenance given vehicles, and so on; it is expected that the inspection and re-inspection data gathered during the course of the program will be used, as the program progresses, to modify the emission limits initially defined so as to achieve the desired percentage emission reduction.

The values for annual inspection, in Table III-3, are one-half of the initial effectiveness following maintenance, it being assumed that linear deterioration to before-maintenance levels will occur over the 12-month period following maintenance. In calculating the effect

TABLE III-3

ESTIMATED REDUCTIONS ACHIEVED BY ANNUAL INSPECTION/MAINTENANCE PROGRAMS

	Initial Failure Rate (%)				
	10	20	30	40	50
Idle Emission Test					
Hydrocarbon Reduction	6	8	10	11	11
Carbon Monoxide Reduction	3	6	8	9	10
Loaded Emission Test					
Hydrocarbon Reduction	8	11	13	14	15
Carbon Monoxide Reduction	4	7	9	11	12

of the proposed semi-annual inspection and maintenance program, a reduction of 15 percent in the emissions of light-duty vehicles has been used, based on the same reasoning.

b. ABIM

The intake manifold air bleed device enables the air-fuel ratio to be increased by metering additional air to the intake manifold in accordance with intake manifold vacuum. Test data show that the initial emissions reductions of carbon monoxide obtained by fitting fleets of tuned precontrolled (pre-1968) light-duty vehicles with this device averaged 58 percent (see Table III-2), and a reduction of this amount has been used for this class of vehicles in calculating the effect of the ABIM program on emissions.

c. High Altitude Modifications

Compensation for the adverse effects on combustion efficiency of decreased air density at high altitude may be accomplished in at least six ways:

- By an altitude controlled air port or valve for admitting more air
- By a variable fuel orifice for restricting fuel flow
- By pressure reduction in the carburetor float chamber for restricting fuel flow
- By throttling the air supply to maintain constant air density
- By a pressure regulated carburetor power metering valve for preventing rich mixtures
- By a barometrically controlled vacuum spark advance for maintaining mean effective cylinder pressure

According to estimates made by the Colorado Department of Public Health, emission reductions of 25 percent for carbon monoxide and 15 percent for hydrocarbons may be expected to result from suitable modifications of this type to 1968-1975 light-duty vehicles. A 25 percent reduction in carbon monoxide emission from vehicles within this class has, therefore, been used in calculating the effect of high altitude modifications on emissions.

d. Curb Parking Prohibition (Salt Lake City)

The proposed plan calls for the prohibition of curb parking in the central business district from 7 to 9:30 a.m. and from 4 to 6 p.m. An estimated reduction of 6 percent in light-duty vehicle emissions within the CBD has been used for this control strategy. This prohibition will bring about a decrease in VMT and some improvement in traffic flow. It should also serve as a stimulus for the use of mass transit and the local shuttle service. Support for the estimated 6 percent reduction is given in Appendix C.

e. Completion of By-Pass (Ogden)

The completion of the by-pass south of Ogden from I-80N to I-15 is expected to eliminate a small amount of through traffic from downtown Ogden (see Appendix C). In developing the control plan, it has been estimated that reduction in vehicular emissions within the CBD will be 1.5 percent.

f. Parking Change (Provo)

At the present time, the flow of traffic along Center Street is greatly impeded by angle parking on both sides of the street. The control plan proposes that angle parking be prohibited on Center

Street from 500 West Street to 100 East Street. Parallel parking will still be allowed. This change from angle to parallel parking will permit traffic to move in two lanes in each direction and will also provide left turn lanes, thus increasing average vehicle speed and so decreasing emissions. In calculating the effect of this control strategy, it has been assumed that vehicle speeds in the CBD will be increased from present average speeds estimated to be 67 percent at 15 mph and 33 percent at 10 mph, to an average speed for all traffic of 15 mph.

g. Central Signal System (Salt Lake City)

This strategy was recommended in the previous Salt Lake City study and a full discussion is contained in Reference 1. It calls for the control of traffic within the problem area by a computer-operated central signal system. In estimating the effect of this strategy, it is assumed that by decreasing traffic idling periods and starts and stops, the vehicle speeds will be increased from the present average speeds estimated to be 50 percent at 15 mph and 50 percent at 19 mph to 50 percent at 19 mph and 50 percent at 22 mph.

h. Mass Transit

It has been estimated by the State that a 2 percent reduction in carbon monoxide emissions will be achieved as a result of continued encouragement to the mass transportation program. In calculating the effect of mass transit on emissions, a 2 percent reduction in light-duty VMT has been assumed in all three cities.

C. EMISSION REDUCTIONS

The suitability and effectiveness of most control devices is a function of vehicle class, with the principal distinction among light-

duty vehicles in the existing vehicle population in Utah being between pre-controlled (pre-1968) vehicles and later models. Table III-4 indicates the relative need for control of pre-1968 and later model vehicles for calendar years 1974 to 1979. From the data in Table III-4, it can be shown that the ABIM strategy is somewhat more effective than the high altitude modification strategy through 1975, but that in later years the relative effectiveness of ABIM decreases due to the steadily decreasing number of pre-1968 vehicles.

The results of emission calculations for the total transportation control plan package are summarized in Table III-5. The reductions tabulated for a strategy are based on the assumption that the strategies listed above it are in effect. Although the internal details of the table depend upon that order in which the strategies are applied, the total reduction achieved by the application of all strategies does not. From the lower two lines of the table, it can be seen that the estimated emission on May 31, 1975 have been brought below the allowable level by the application of the complete transportation control package.*

It should be pointed out that the emissions in Table III-5 have been presented with somewhat more precision than is warranted to avoid the inaccurate results and confused presentation that would result from the accumulation of rounding errors through the series of calculations.

D. ECONOMIC AND SOCIAL IMPACT

A thorough quantitative assessment of the impact of the plan on the economic and social fabric of the community has not been possible due to the lack of time and the innate complexity of the issue. There are, however, three types of impact to be considered. First, vehicle owners may have to assume the direct costs of emission abatement equipment to

* The effect of the transportation control package on emissions from May 31, 1975 to December 31, 1979 is shown in Appendix H.

TABLE III-4

PERCENT OF LIGHT DUTY VEHICULAR CARBON MONOXIDE EMISSIONS BY MODEL YEAR

YEAR (as of Dec. 31)	EMISSIONS (Percent)								
	SALT LAKE CITY			OGDEN			PROVO		
	PRE-1968	1968-1974	POST-1974	PRE-1968	1968-1974	POST-1974	PRE-1968	1968-1974	POST-1974
1974	38.2	61.6	0.2	39.6	60.2	0.2	39.8	60.0	0.2
1975	32.1	65.6	2.3	32.8	65.2	2.0	33.1	64.9	2.0
1976	24.3	70.5	5.2	23.9	71.5	4.6	24.3	71.1	4.6
1977	20.7	73.0	6.3	18.5	76.0	5.5	19.0	75.1	5.9
1978	18.5	74.0	7.5	15.2	77.7	7.1	15.8	76.7	7.5
1979	16.6	73.3	10.1	12.7	77.6	9.7	13.3	77.2	9.5

TABLE III-5

CONTROL STRATEGY EFFECTS ON CARBON MONOXIDE
EMISSIONS ON MAY 31, 1975

	VEHICULAR EMISSIONS ($kg/8hr/mi^2$)		
	SALT LAKE CITY	OGDEN	PROVO
Base Line (FMVCP only)	9,765	7,036	5,697
Expected Reductions:			
a. Inspection and Maintenance (semi-annual)	1,429	1,009	817
b. Intake Manifold Air Bleed Device (Pre-1968 light duty vehicles)	1,680	1,222	997
c. High Altitude Modification (1968-1974 light duty vehicles)	1,279	889	717
d. Curb Parking Restriction	308	-	-
e. By-Pass	-	59	-
f. Parking Change (Angle to Parallel)	-	-	370
g. Central Signal System	744	-	-
h. Mass Transit	82	71	51
Total Reductions	5,522	3,250	2,952
Emissions Remaining	4,243	3,786	2,745
Allowable	4,493	3,791	2,768

bring their vehicles into compliance. Second, reduction in the mobility of workers and consumers could have some impact on the economic fabric of the community. Third, interference with the ability of citizens to move as freely may alter the lifestyle of the region slightly. Obviously, the severity of the impact depends on the degree of vehicle usage restrictions, on the manner that direct costs of abatement equipment are financed, and the degree to which the effects can be ameliorated by the improvement of the transit system.

Since the transportation control plan is largely dependent on inspection and maintenance and the installation of control devices, the principal effect may well be the direct cost of these items to the individual light-duty vehicle owner. The cost of inspection need be only $5.00 and the cost of a typical maintenance requiremert has been estimated at $15 to $25, based on an annual inspection. For a semi-annual program, the maintenance costs per visit presumably would be less, but the annual cost per vehicle would necessarily be somewhat greater. The installed cost of the ABIM is about $60, and the installed cost of possible options for the high altitude modification is estimated to be $20 to $35. No increase in gasoline consumption is anticipated as a result of the installation of the proposed control devices. Thus the total cost of these control measures might average about $100 for the owner of a pre-1968 light-duty vehicle, and about $70 for the owner of a 1968 to 1974 light-duty vehicle. If these costs fall directly on the individual light-duty vehicle owner, the specific burden will weigh more heavily on the low-income families who tend to own the older cars.

Any direct or indirect effects of the plan on the economy of the area are primarily dependent on the extent of the reduction in VMT.

Since the degree of restriction is relatively small, it is expected that the principal effects will be more a matter of social adjustments than of serious economic consequences.

E. OBSTACLES

Salt Lake City has obligated funds and is engaging consultants to design the computer-controlled signal system and prepare specifications, and the State legislature recently granted authority to inspect emission control devices, to test vehicle emissions, and to control emissions of pollutants.

The most serious obstacles to full implementation of the plan by May 31, 1975, appear to be the time required to construct and install the signal system, the availability of the control devices, and the training of inspection and maintenance crews. Legislation would be needed requiring the installation of the control devices, and to appropriate funds for the program.

REFERENCES

1. EPA, Transportation Controls to Reduce Motor Vehicle Emissions in Salt Lake City, Utah. Prepared by GCA Corporation, Bedford, Massachusetts (December 1972).

2. EPA, Control Strategies for In-Use Vehicles, Office of Air and Water Programs, Mobile Source Pollution Control Program (November 1972).

3. EPA, An Interim Report on Motor Vehicle Emissions Estimation, Kircher, D.S. and Armstrong, D.P., October 1972, Revised January 1973.

APPENDIX A

CALCULATION OF VEHICLE MILES OF TRAVEL

I. GENERAL

The general procedure followed was to select critical areas of the Wasatch Front Intrastate Air Quality Control Region by inspection of traffic counts, land use patterns, existing highway systems, and to calculate and project vehicle miles of travel based upon the existing data.

For the purposes of computing current and projected vehicle miles of travel, the study area was broken down into zones of approximately one square mile each. These zones centered on the heavily traveled core areas in the three cities, Salt Lake, Ogden and Provo, Utah.

The next step was to determine the existing daily vehicle miles of travel by multiplying the current average daily traffic figures times the street and highway mileage in each zone. Current daily traffic volumes were obtained from several sources; including the Salt Lake City Traffic Engineering Department, the Salt Lake County Traffic Engineering Department, Utah State Department of Highways, the City of Provo, Utah and the City of Ogden, Utah. On streets where current traffic counts were not available, estimates of daily traffic were made based upon the location, type of street, and actual counts on streets in the area. An expansion factor based upon information provided by the Utah State Highway Department was then applied to the current daily vehicle miles of travel to estimate projected travel in each zone.

Information on traffic variations, vehicle mix, trip purpose, average operating speeds, vehicle density and trip length was obtained from the current urban transportation studies in Salt Lake, Ogden and Provo.

II. SALT LAKE CITY

Figure A-1 represents the average daily traffic volumes, 1970-1971, in Salt Lake City. This traffic flow map was prepared from information furnished by the City of Salt Lake Traffic Engineering Department and by the Utah State Department of Highways. Using these volumes and estimates of traffic volumes on streets where traffic counts were not available, estimates of 1970 vehicle miles of travel were calculated for zone H of the core area as identified in Figure A-2. An earlier study entitled "Transportation Controls to Reduce Motor Vehicle Emissions in Salt Lake City, Utah", dated 1972, (Ref. 1) produced similar estimates for the total study area broken down into 239 zones ranging in size from .07 to .10 square miles each. Based upon analysis of this study, the worst concentration of vehicle emissions was found to be concentrated in zone H of the core area of Salt Lake City and later calculations were limited to this area. The 1970 daily vehicle miles of travel were calculated by measuring the length of each street or highway facility and multiplying that length by the daily traffic volumes obtained from the most current traffic flow data. For roadway segments where current traffic volume counts were not available estimates were made based upon the location, type of street, and traffic counts on adjacent streets in the area. Table A-1 represents

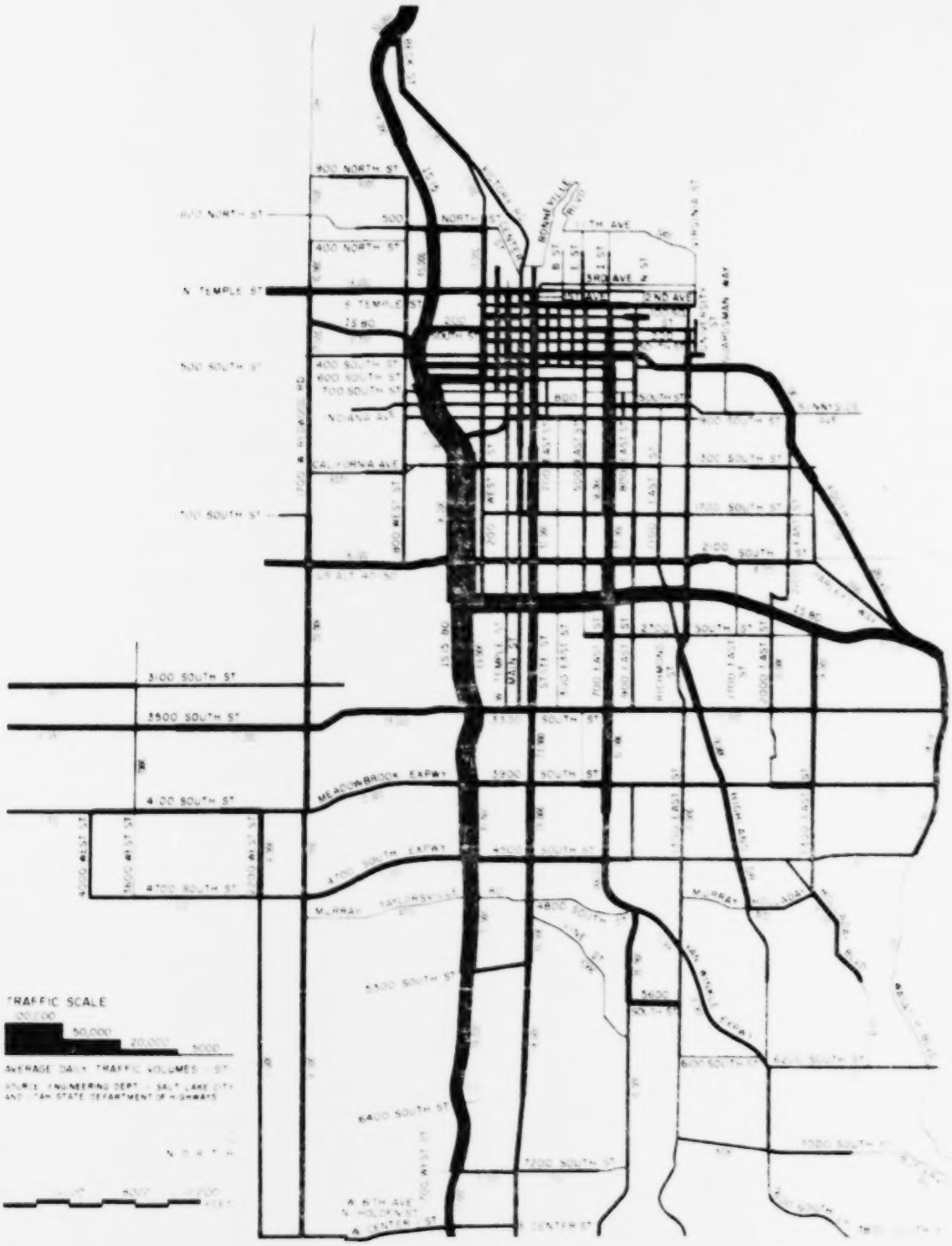

Figure A-1. Average daily traffic volume in Salt Lake City in 1971.

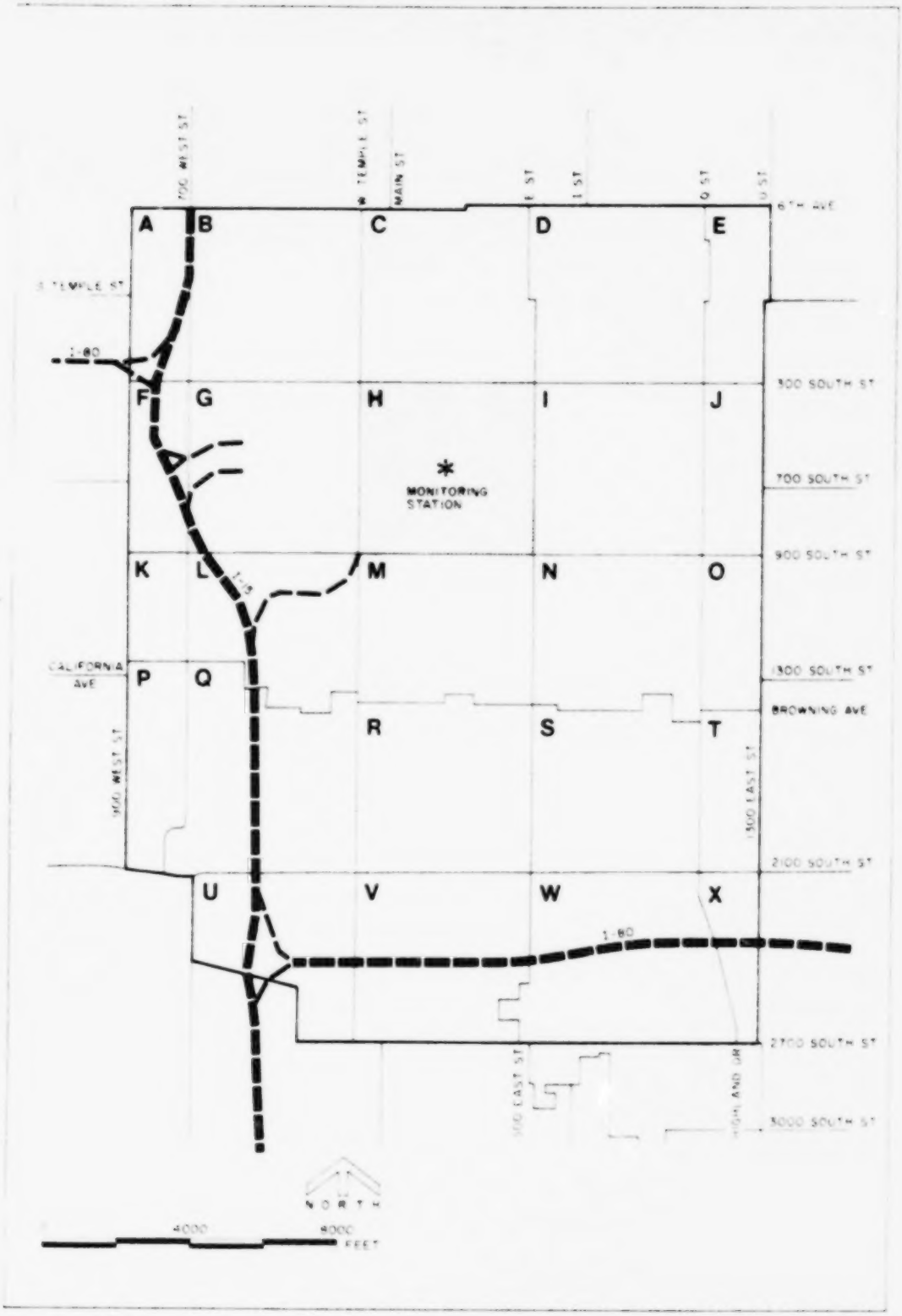

Figure A-2. Area map of Salt Lake City showing location of the monitoring station and the street boundaries of Zone H.

Table A-1

DAILY VEHICLE MILES OF TRAVEL IN ZONE H
(0.81 SQUARE MILES) IN DOWNTOWN SALT LAKE CITY
(for years 1970 through 1982 by Vehicle Class)

	DAILY VEHICLE MILES OF TRAVEL (000)			
YEAR	Light Duty	Heavy Duty	Other	Total
1970	156.1	1.8	-	157.9
1971	160.9	1.9	-	162.8
1972	165.8	1.9	-	167.7
1973	170.6	2.0	-	172.6
1974	175.5	2.0	-	177.5
1975	180.3	2.1	-	182.4
1976	184.9	2.2	-	187.1
1977	189.8	2.2	-	192.0
1978	194.8	2.3	-	197.1
1979	199.5	2.3	-	201.8
1980	204.3	2.4	-	206.7
1981	209.2	2.4	-	211.6
1982	214.0	2.5	-	216.5

a summary of estimated daily vehicle miles of travel for the years 1970 through 1982 by class of vehicle. For a discussion of travel by class of vehicle, see Reference 1.

The next step was to calculate vehicular travel for the 4:00 P.M. to Midnight time period and by type of facility and vehicle speed. Table A-2 depicts the percent travel of daily traffic by hour of the day. Thus, it was calculated that 42.5 percent of daily travel occurred during the 8-hour period from 4:00 P.M. to Midnight. The resulting estimates of vehicle miles of travel for zone H are shown in Table A-3.

Table A-3 also illustrates the existing vehicular speeds which vary from an average of 15 m.p.h. during peak traffic periods to 19 m.p.h. during off-peak times. For zone H, all vehicular travel was over local streets.

Table A-4 provides information on the age of the existing automobile population obtained from R.L. Polk and Company.

III. PROVO

Similar techniques were employed to calculate vehicle miles of travel for zone P-1 in Provo, Utah. Figure A-3 illustrates the one square mile area encompassed by zone P-1 which includes the heavily traveled streets in Provo's Central Business District. Figure A-4 illustrates the current average daily traffic volumes in the area based upon traffic counts obtained from the City of Provo and the Utah State Department of Highways. The resulting daily vehicle miles of travel are presented in Table A-5 by class of vehicle.

Inspection of Table A-6, Percent of Daily Traffic by Hour, shows

Table A-2

PERCENT OF DAILY TRAFFIC BY HOUR

Salt Lake, Utah

HOUR	PERCENT
12-1 A.M.	1.2
1-2 A.M.	0.6
2-3 A.M.	0.3
3-4 A.M.	0.3
4-5 A.M.	0.3
5-6 A.M.	0.7
6-7 A.M.	2.5
7-8 A.M.	8.4
8-9 A.M	6.4
9-10 A.M.	4.7
10-11 A.M.	4.8
11-12 A.M.	5.1
12-1 P.M.	5.1
1-2 P.M.	5.1
2-3 P.M.	5.5
3-4 P.M.	6.5
4-5 P.M.	9.1
5-6 P.M.	9.4
6-7 P M.	6.4
7-8 P.M.	5.1
8-9 P.M.	4.0
9-10 P.M.	3.6
10-11 P M.	2.9
11-12 P.M.	2.0
TOTAL	100.0

SOURCE: Salt Lake Area Transportation Study, Volume 1, Current Travel Inventory, Wilbur Smith and Associates, 1963.

Table A-3

VEHICLE MILES OF TRAVEL BETWEEN 4:00 P.M. AND MIDNIGHT
IN ZONE H (0.81 SQUARE MILES) IN DOWNTOWN SALT LAKE CITY
(for years 1970 through 1982 by Vehicle Class)

	VEHICLE MILES OF TRAVEL (000)			
YEAR	Light Duty	Heavy Duty	Other	Total
1970	66.3	0.8	-	67.1
1971	68.4	0.8	-	69.2
1972	70.5	0.8	-	71.3
1973	72.6	0.8	-	73.4
1974	74.6	0.8	-	75.4
1975	76.6	0.9	-	77.5
1976	78.7	0.9	-	79.5
1977	80.7	0.9	-	81.6
1978	82.8	0.9	-	83.7
1979	84.8	1.0	-	85.8
1980	86.9	1.0	-	87.9
1981	88.9	1.0	-	89.9
1982	91.0	1.0	-	92.0

Existing Vehicle Speeds 4:00-6:00 P.M. -- 15 m.p.h.
Existing Vehicle Speeds 6:00 P.M. to Midnight -- 19 m.p.h.
All Local Street Travel - No Freeways.

Table A-4

VEHICLE AGE MIX

Salt Lake County

(as of July 1, 1971)

MODEL YEAR	PERCENT
1971	7.3
1970	8.5
1969	9.6
1968	9.2
1967	8.6
1966	9.1
1965	9.3
1964	8.1
1963	7.4
1962	6.2
1961	4.2
1960	3.5
1959	2.4
1958	1.1
1957	1.3
1956	1.2
Prior to 1956	3.0

SOURCE: Compiled from official state records (passenger car registrations) by R.L. Polk and Company.

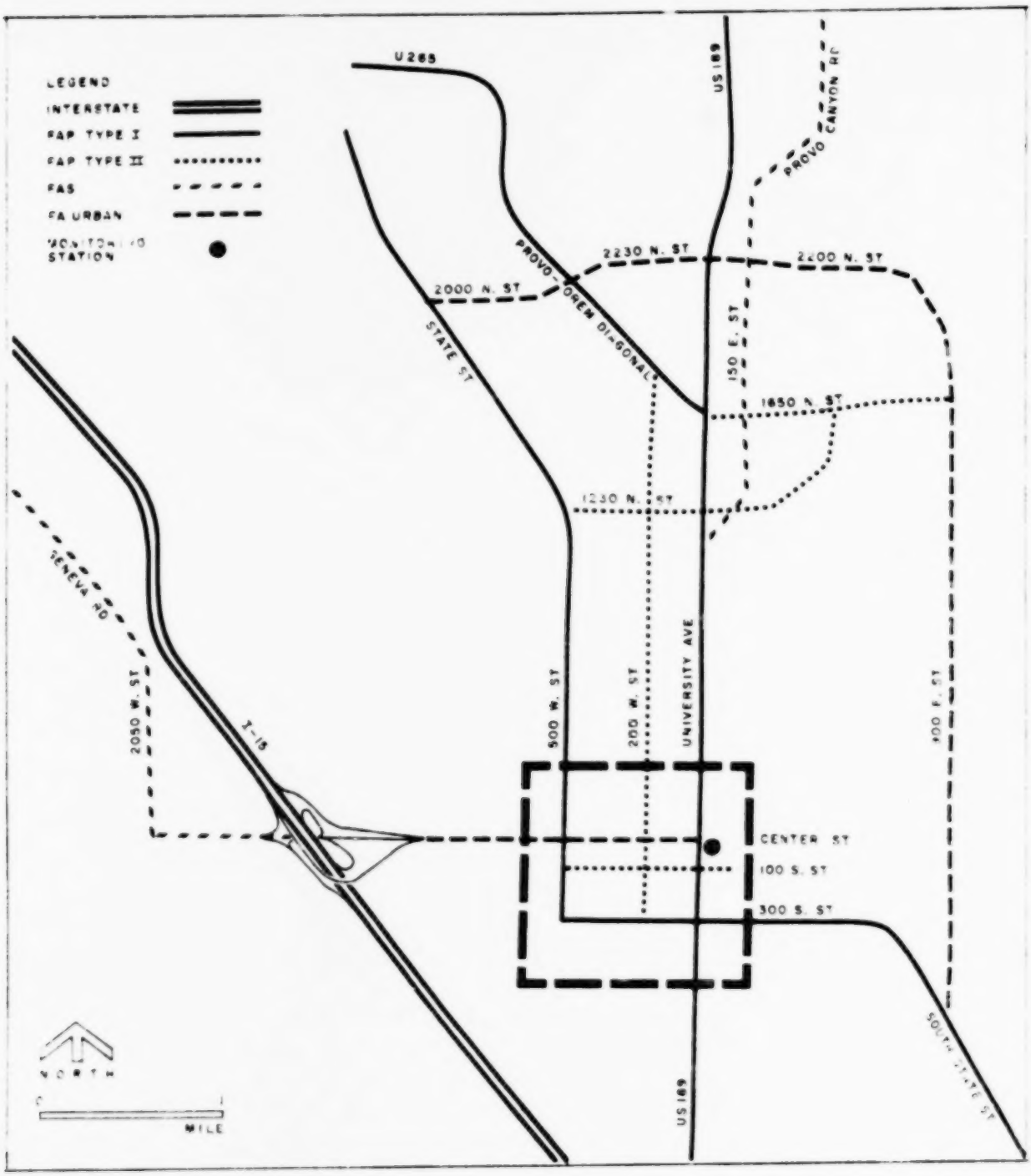

Figure A-3. Area map of Provo showing location of the monitoring station and the approximate bounds of Zone P-1.

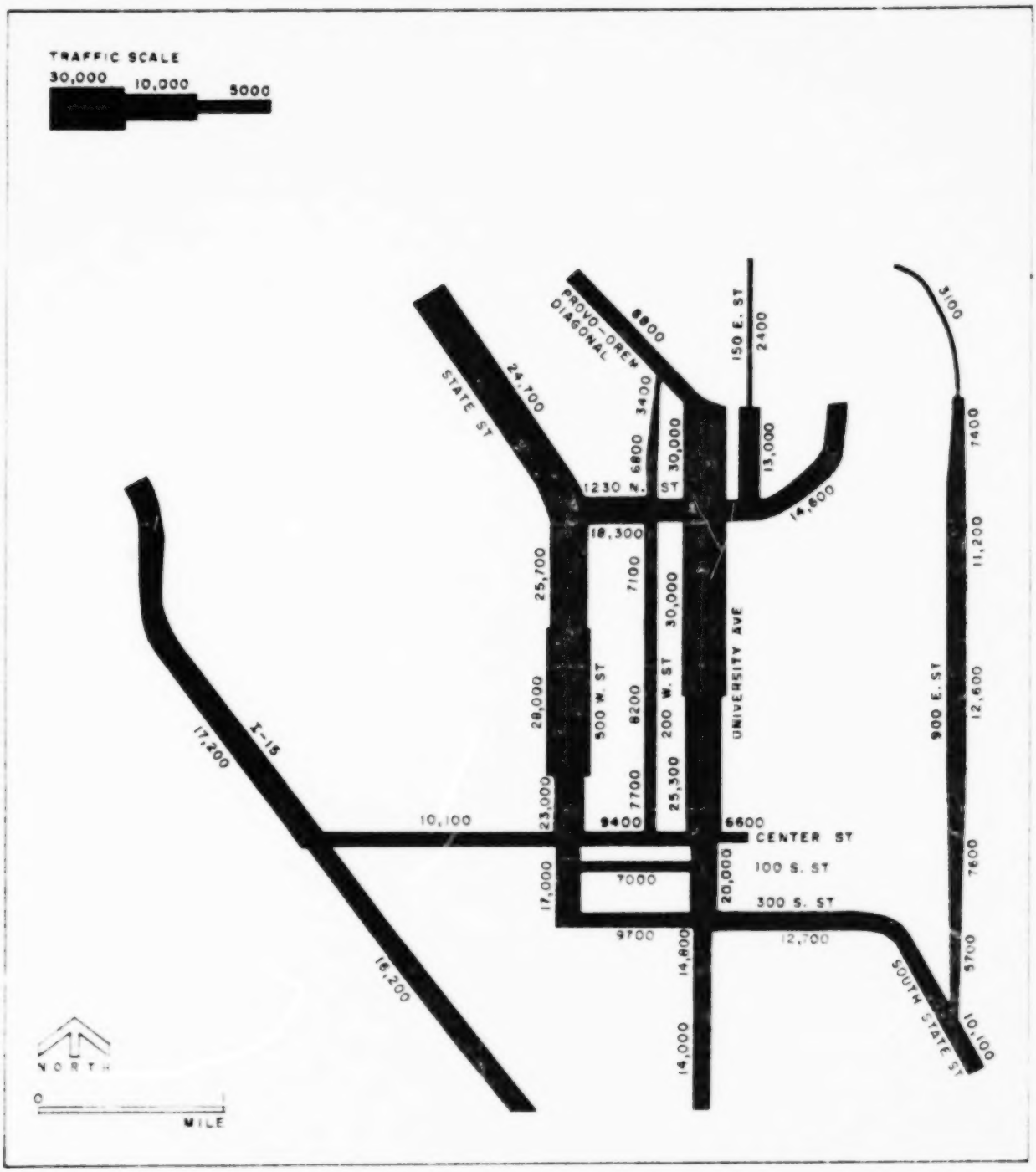

Figure A-4. Average daily traffic volume in Provo in 1971.

Table A-5

DAILY VEHICLE MILES OF TRAVEL IN ZONE P-1
(1.0 SQUARE MILES) IN DOWNTOWN PROVO
(for years 1971 through 1982 by Vehicle Class)

	DAILY VEHICLE MILES OF TRAVEL (000)			
YEAR	Light Duty	Heavy Duty	Other	Total
1971	87.3	1.8	.9	90.0
1972	90.8	1.9	.9	93.6
1973	94.4	1.9	1.0	97.3
1974	98.2	2.0	1.0	101.2
1975	102.0	2.1	1.1	105.2
1976	106.1	2.2	1.1	109.4
1977	109.7	2.3	1.1	113.1
1978	113.2	2.3	1.1	116.7
1979	117.5	2.4	1.2	121.1
1980	121.0	2.5	1.2	124.7
1981	125.0	2.6	1.3	128.9
1982	128.6	2.7	1.3	132.6

Table A-6

PERCENT OF DAILY TRAFFIC BY HOUR

Provo, Utah

HOUR	PERCENT
12-1 A.M.	1.3
1-2 A.M.	0.6
2-3 A.M	0.4
3-4 A.M.	0.4
4-5 A.M	0.5
5-6 A.M.	0.9
6-7 A M.	2.4
7-8 A.M.	6.1
8-9 A.M	5.4
9-10 A.M	4.8
10-11 A.M	5.2
11-12 A.M.	5.4
12-1 P M.	5.7
1-2 P.M	5.7
2-3 P.M.	5.9
3-4 P.M.	7.2
4-5 P.M.	8.9
5-6 P.M.	8.2
6-7 P.M.	6.2
7-8 P.M.	5.5
8-9 P.M.	4.3
9-10 P.M.	3.6
10-11 P.M.	3.1
11-12 P.M.	2.3
TOTAL	100.0

SOURCE: Provo Area Transportation Study, Volume 1, 1967.

that 42.1 percent of daily traffic occurs during the 8-hour period from 4:00 P.M. to Midnight. Thus, Table A-7 shows the estimated vehicle miles of travel for zone P-1 for the 8-hour period from 4:00 P.M. to Midnight. Vehicle speeds were estimated to be 10 m.p.h. on Center Street and 15 m.p.h. on other streets based upon the Provo City TOPICS Plan, prepared by Rollins, Brown and Gunnell, Inc., in 1972.

Shown in Table A-8 is the number of registered passenger vehicles by model year as compiled from official state records by R.L. Polk and Company.

IV. OGDEN

Estimates of vehicle miles of travel for zone O-1 in the Central Business District of Ogden, see Figure A-5, were obtained using existing traffic counts available from the City of Ogden and the Utah State Department of Highways. Figure A-6 depicts the current traffic flow in the Ogden area.

Using the current traffic counts, spot checks on travel by types of vehicles, and growth projections by the State Department of Highways, estimates of daily vehicle miles of travel were produced for zone O-1, see Table A-9.

The daily estimates of travel were further refined to provide estimates of travel for the 8-hour period from 4:00 P.M. to Midnight as a result of the hourly traffic variations shown in Table A-10. Estimates of vehicle speeds ranged from 15 m.p.h. on local streets to 19 m.p.h. on arterial streets in zone O-1. There was no freeway

Table A-7

VEHICLE MILES OF TRAVEL BETWEEN 4:00 P.M. AND MIDNIGHT IN ZONE P-1 (1.0 SQUARE MILES) IN DOWNTOWN PROVO (for years 1971 through 1982 by Vehicle Class)

	VEHICLE MILES OF TRAVEL (000)			
YEAR	Light Duty	Heavy Duty	Other	Total
1971	36.7	0.8	0.4	37.9
1972	38.2	0.8	0.4	39.4
1973	39.7	0.8	0.4	40.9
1974	41.3	0.9	0.4	42.6
1975	43.0	0.9	0.4	44.3
1976	44.7	0.9	0.5	46.1
1977	46.2	0.9	0.5	47.6
1978	47.7	1.0	0.5	49.2
1979	49.4	1.0	0.5	50.9
1980	50.9	1.1	0.5	52.5
1981	52.6	1.1	0.5	54.2
1982	54.1	1.1	0.6	55.8

Existing Vehicle Speeds - Center Street, 10 m.p.h.
Existing Vehicle Speeds - Other Streets, 15 m.p.h.
All Local Street Travel - No Freeways.

Table A-8

VEHICLE AGE MIX

Utah County

(as of July 1, 1972)

MODEL YEAR	PERCENT
1972	6.6
1971	7.5
1970	8.1
1969	9.8
1968	8.7
1967	7.9
1966	9.0
1965	9.0
1964	7.8
1963	6.5
1962	5.5
1961	3.3
1960	2.6
1959	1.9
1958	1.0
1957	1.1
Prior to 1957	3.7

SOURCE: Compiled from official state records (passenger car registrations) by R.L. Polk and Company.

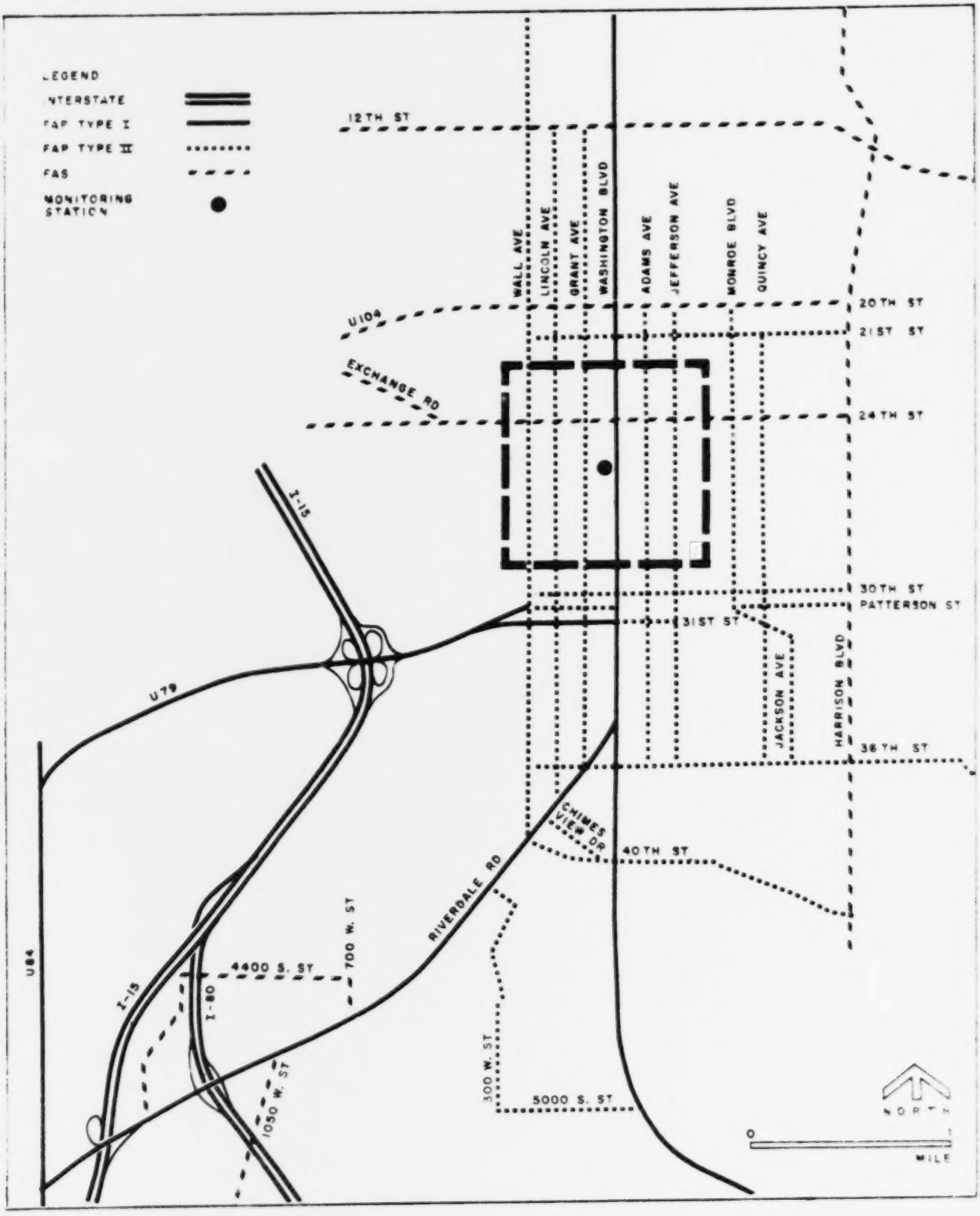

Figure A-5. Area map of Ogden showing location of the monitoring station and the approximate bounds of Zone 0-1.

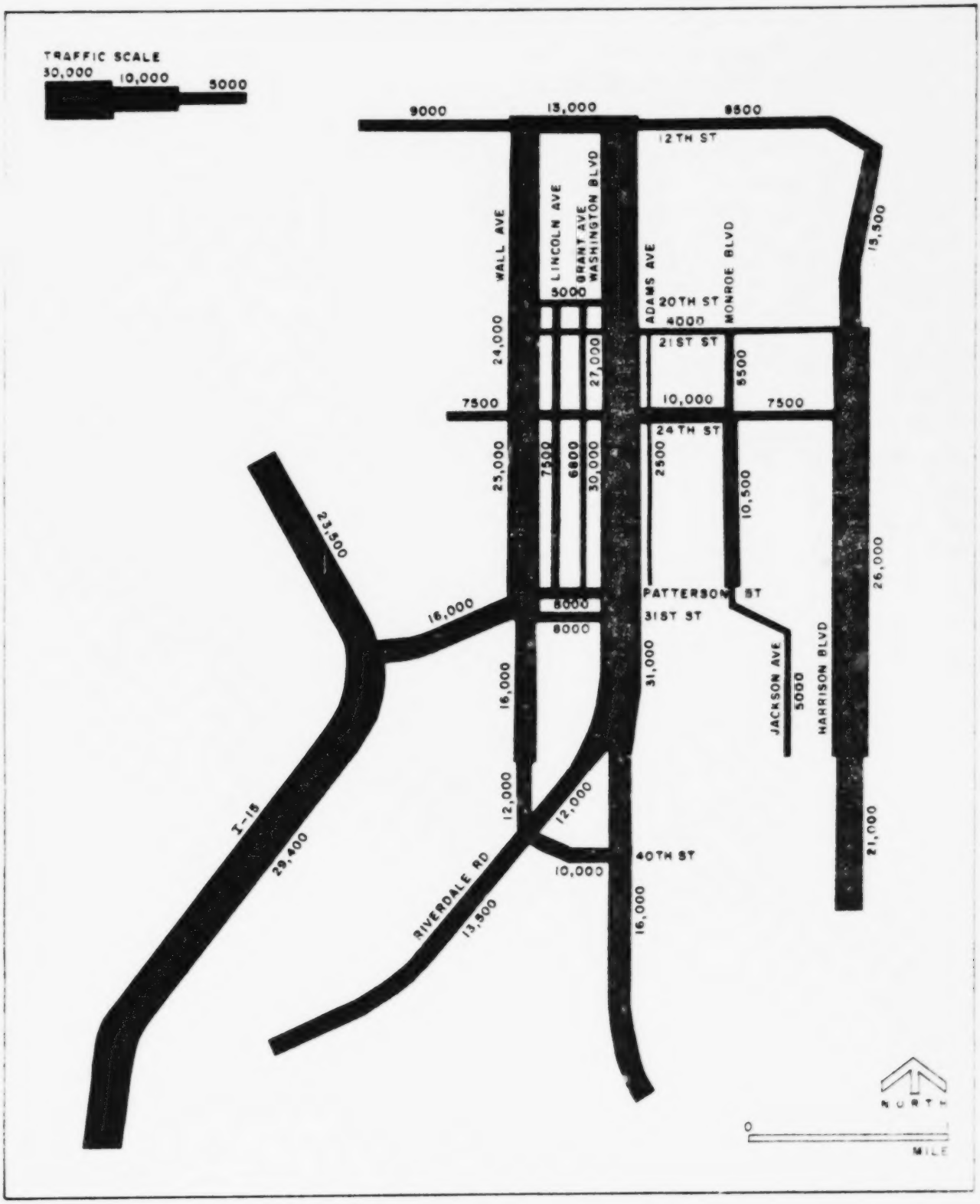

Figure A-6. Average daily traffic volumes in Ogden in 1971.

Table A-9

DAILY VEHICLE MILES OF TRAVEL IN ZONE 0-1
(1.0 SQUARE MILES) IN DOWNTOWN OGDEN
(for years 1971 through 1982 by Vehicle Class)

	DAILY VEHICLE MILES OF TRAVEL (000)			
YEARS	Light Duty	Heavy Duty	Other	Total
1971	109.6	2.3	1.1	113.0
1972	116.0	2.4	1.2	119.6
1973	122.8	2.5	1.3	126.6
1974	129.9	2.7	1.3	133.9
1975	137.4	2.8	1.4	141.7
1976	143.6	3.0	1.4	148.0
1977	148.4	3.1	1.5	153.0
1978	154.6	3.2	1.6	159.4
1979	160.2	3.3	1.7	165.2
1980	165.2	3.4	1.7	170.3
1981	170.8	3.5	1.8	176.1
1982	176.2	3.6	1.8	181.7

Table A-10

PERCENT OF DAILY TRAFFIC BY HOUR

Ogden, Utah

HOUR	PERCENT
12-1 A.M	1.4
1-2 A.M.	0.7
2-3 A.M.	0.3
3-4 A.M.	0.3
4-5 A.M.	0.3
5-6 A.M.	0.8
6-7 A.M.	3.2
7-8 A.M.	6.0
8-9 A.M.	5.0
9-10 A.M	4.4
10-11 A M.	4.7
11-12 A.M.	5.1
12-1 P.M.	5.7
1-2 P.M.	5.5
2-3 P.M.	5.8
3-4 P.M.	6.8
4-5 P.M.	9.4
5-6 P.M.	8.4
6-7 P.M.	6.5
7-8 P.M.	5.4
8-9 P.M.	4.6
9-10 P.M.	4.2
10-11 P.M.	3.3
11-12 P.M.	2.2
TOTAL	100.0

SOURCE: Ogden Area Transportation Study, Volume 1, 1966.

mileage.

Table A-11 presents the estimated VMT for zone 0-1 for the 8-hour period from 4:00 P.M. to Midnight by class of vehicle.

Table A-12 presents the vehicle age mix for Weber County as compiled by R.L. Polk and Company from official state records of passenger car registrations.

Table A-11

VEHICLE MILES OF TRAVEL BETWEEN 4:00 P.M. AND MIDNIGHT IN ZONE 0-1 (1.0 SQUARE MILES) IN DOWNTOWN OGDEN (for years 1971 through 1982 by Vehicle Class)

	VEHICLE MILES OF TRAVEL (000)			
YEAR	Light Duty	Heavy Duty	Other	Total
1971	48.2	1.0	0.5	49.7
1972	51.0	1.1	0.5	52.6
1973	54.0	1.1	0.6	55.7
1974	57.1	1.2	0.6	58.9
1975	60.5	1.2	0.6	62.3
1976	63.2	1.3	0.6	65.1
1977	65.3	1.3	0.7	67.3
1978	68.0	1.4	0.7	70.1
1979	70.5	1.5	0.7	72.7
1980	72.7	1.5	0.7	74.9
1981	75.1	1.5	0.8	77.4
1982	77.5	1.6	0.8	79.9

Existing Vehicle Speeds - Arterial Streets, 19 m.p.h.
Existing Vehicle Speeds - Local Streets, 15 m.p.h.
No Freeways.

Table A-12

VEHICLE AGE MIX

Weber County

(as of July 1, 1972)

MODEL YEAR	PERCENT
1972	6.2
1971	7.9
1970	7.9
1969	8.7
1968	8.8
1967	8.9
1966	9.3
1965	9.0
1964	7.6
1963	6.9
1962	5.3
1961	3.3
1960	2.7
1959	1.9
1958	0.9
1957	1.0
Prior to 1957	3.7

SOURCE: Compiled from official state records (passenger car registrations) by R.L. Polk and Company.

APPENDIX B

GENERAL DISCUSSION OF CONTROL STRATEGIES

I. GENERAL

Each city in the Wasatch Front Intrastate Air Quality Control Region has unique transportation systems and requires individual evaluation to determine the most appropriate control strategy to meet the national ambient air quality standards.

There is a broad variety of possible transportation control measures designed to reduce total vehicle miles of travel or improve vehicle speeds and reduce vehicle emissions. Table B-1 illustrates candidate control measures considered in this study.

As shown in the main body of this report, vehicle emissions will have to be reduced by approximately one-half, in addition to the reductions brought about by the Federal Motor Vehicle Emission Control Programs, if the 8-hour national carbon monoxide standard is to be met by May 31, 1975.

II. CONTROL MEASURES REJECTED

A number of possible control measures were studied and rejected because of a variety of reasons. These include:

Gasoline Rationing - Gasoline rationing is an extremely unpopular technique for reducing vehicle travel. Rationing can, if permitted, increase the cost of gasoline. It would also be difficult to implement and enforce. For these reasons and because more acceptable measures were available which would produce the desired reduction in vehicle emissions, gasoline rationing was not selected as a control strategy.

Table B-1

CANDIDATE CONTROL MEASURES

VMT-REDUCING MEASURES

Travel Pattern Modification

- Stagger work hours
- Vehicle-free zones
- Bypass through traffic

Reduce Vehicle Travel Demand

- Improve mass transit service
- Restrict parking
- Shorten work week
- Peripheral parking
- Road pricing
- Gasoline rationing
- Periodic vehicle prohibition
- Increase fuel tax
- Car pooling
- Increase parking fees

VEHICLE-EMISSION-REDUCING MEASURES

Traffic Flow Improvements

- Surveillance and control
- Design and operational improvements
- Truck loading zones
- Driver advisory displays

Source Modification

- Inspection/maintenance program
- Exhaust emission control devices
- Gaseous fuel conversion

Gasoline rationing, however, is a most effective method of achieving immediate reduction in VMT and, therefore, should be considered if other measures prove to be infeasible or impossible to implement prior to June 1975.

Road, Pricing and Tolls - The imposition of tolls on strategic highways and interstate freeways was also rejected because tolls are practically unknown in the State of Utah, and it was felt that they would be very unpopular to the motorists. In addition, imposition of tolls in and around the Central Business Districts of Salt Lake, Ogden and Provo, Utah, could seriously distort the normal traffic flow pattern and force heavy volumes of traffic on secondary or collect streets. Tolls, however, would have the advantage of providing additional revenue for use in supporting or subsidizing mass transit in the region.

Staggered Work Hours - Staggered work hours could be an effective control measure in larger metropolitan areas; however, for a smaller urban area such as Ogden and Provo, staggered work hours could disrupt existing carpools. Staggered work hours were also rejected because of their relatively minor impact on vehicle travel.

Vehicle Free Zones - Vehicle free zones were considered to be a possibility for the Central Business Districts of Ogden, Provo and Salt Lake City; however, in these areas which rely heavily on private automobile travel, the prohibition of private automobiles in such large areas of the Central Business Districts would require an extensive shuttle bus system and peripheral parking in order to maintain a viable and economically sound business area. As a long term measure, this control

technique has exciting possibilities; however, for the short term, vehicle free zones were considered to be unrealistic and unworkable.

Other measures were considered but rejected because of their relatively minor impact on vehicle travel. These include:

- Carpooling;
- Shortened work week; and,
- Peripheral parking program.

III. CONTROL MEASURES PROPOSED

Based on considerations of effectiveness, cost and availability, the following vehicle or mobile source control measures are proposed:

- A semi-annual inspection and maintenance program;
- An Intake Manifold Air Bleed Device (ABIM) on pre-1968 light duty gasoline powered vehicles; and,
- A high altitude modification device on 1968-1974 light duty gasoline powered vehicles.

These measures are proposed to be effectutated on a regionwide basis (Weber, Davis, Salt Lake and Utah Counties) and therefore produce the greatest benefit to the region and have the additional advantage of reducing emissions throughout the urban portion of the AQCR, thus relieving possible areas of high concentration which are not yet detected.

Transportation control measures proposed include:

- Installation of a Computerized Traffic Signal System in Salt Lake City;
- Curb parking prohibition in the Salt Lake City CBD;

- Completion of I-800N by-pass in Ogden;
- Mass transit improvements in all three cities.

APPENDIX C
SELECTED EMISSION CONTROL MEASURES

I. INTRODUCTION

The control measures selected for implementation in the Wasatch Front Intrastate AQCR include a variety of measures, many previously proposed by the Utah State Department of Social Services, Division of Health, as part of its Implementation Plan. These measures have been summarized and described briefly in Section III of this report.

This appendix describes the selected measures in greater detail, documents the calculated emission reduction, and describes basic implementation strategy.

Several measures were selected for application throughout the four urban counties of the AQCR and, therefore, apply to each city. These measures will be presented first with later sections devoted to measures peculier to individual cities.

II. REGION-WIDE MEASURES

A. VEHICLE INSPECTION AND MAINTENANCE

1. General

The recommended vehicle inspection and maintenance program includes semiannual inspection of emission-related vehicle components and an "idle-mode" emissions test. This test measures vehicle emissions while the engine is idling at the manufacturer's recommended engine speed. If the test-determined exhaust emission exceeds predetermined rejection levels or if any of the other emission-control devices or modifications are malfunctioning or have been tampered with, the vehicle owner will be required to have corrective maintenance performed and the vehicle re-inspected.

A vehicle maintenance and inspection program was originally a part of the State of Utah's Implementation Plan. Such a program, based upon EPA research, is a very effective method of reducing

emissions and does not restrict vehicle travel to any significant degree. In addition, the Utah State Legislature has authorized the inspection of emission control devices, the testing of vehicle emissions and the control of vehicle emissions. Moreover, the program can be coordinated with Utah's present vehicle safety inspection program. A state vehicle safety inspection program charged with the added responsibility of an emissions control program could be an efficient and cost-effective method of implementing an inspection and maintenance program.

The simpler "idle-mode" emission test is proposed based upon recent EPA research efforts on testing procedures.

In summary, the "idle-mode" emission test is effective in determining high emitters. It is comparable to or better than most other systems in terms of cost effectiveness and is well-suited for inspection by private garages.

2. Effectiveness of Inspection and Maintenance Measures

The effectiveness of inspection and maintenance programs has been determined by EPA. The resulting emission reductions, Table C-1, indicates that the effectiveness depends on the initial failure rate, which of course depends on the stringency of the defined limits for passing inspections. The values for annual inspection, in Table C-1, are one-half the initial effectiveness immediately following maintenance, since it has been assumed that linear deterioration to before-maintenance levels will occur over a 12-month period following inspection. To calculate the effectiveness of the proposed semi-annual program, it has been estimated that there would be a 15 percent reduction in emissions based on the same reasoning, and an expected initial failure rate of 50 percent.

The figures in Table C-1 are functions of the average distributions of emissions, the amount of pre-inspection maintenance given vehicles, and other factors. It is anticipated that, during

Table C-1

ESTIMATED REDUCTIONS ACHIEVED BY ANNUAL INSPECTION/MAINTENANCE PROGRAMS

	INITIAL FAILURE RATE (%)				
	10	20	30	40	50
Idle Emission Test					
Hydrocarbon Reduction	6	8	10	11	11
Carbon Monoxide Reduction	3	6	8	9	10
Loaded Emission Test					
Hydrocarbon Reduction	8	11	13	14	15
Carbon Monoxide Reduction	4	7	9	11	12

the course of the program, inspection data can be utilized to modify somewhat the initial emission limits in order to achieve the desired emission reduction. Thus, there is some flexibility built into the program, which with experience, can permit adjusting acceptable emission limits to achieve the desired results.

B. AIR BLEED TO INTAKE MANIFOLD (ABIM)

1. General

The proposed installation of an air bleed to intake manifold device enables the air fuel ratio to be increased by metering additional air into the intake manifold. This device has been found to be effective in reducing carbon monoxide emission, but is applicable to only pre-controlled (pre-1968) vehicles. The device is relatively inexpensive, approximately $60.00 installed and is relatively maintenance free.

Installation of these devices should be programmed over a minimum 12-month period to avoid delays during installation. Installation should be performed at state-owned or certified garages only. Certificates should be issued to each vehicle owner following installation of the ABIM device. To ensure compliance, vehicle owners should be required to present these certificates to obtain new license tags.

2. Effectiveness of ABIM Devices

Test data shows that the initial emission reductions of carbon monoxide obtained by installing ABIM devices on tuned pre-controlled (pre-1968) light-duty vehicles averaged 58 percent, see Table C-2.

Thus, a 58 percent reduction in carbon monoxide emissions for pre-controlled vehicles only has been used in calculating the effect of the ABIM program on vehicle emissions.

Table C-2

REDUCTION ACHIEVED BY CONTROL DEVICES

CONTROL DEVICE	AVERAGE REDUCTION (%)	
Combination	HC	CO
Lean Idle Air/Fuel Ratio Adjustment and Vacuum Spark Advance Disconnect	25%	9%
Oxidizing Catalytic Converter and Vacuum Spark Advance Disconnect	68%	63%
Air Bleed to Intake Manifold	21%	58%
Exhaust Gas Recirculation and Vacuum Spark Advance Disconnect	12%	31%
Oxidizing Catalytic Converter*	50%	50%

* On vehicles already controlled to meet federal exhaust emission standards.

C. HIGH ALTITUDE MODIFICATIONS

1. General

In order to compensate for the high altitude conditions of the Wasatch Front, a high altitude efficiency modification is proposed for all ight-duty 1968-1974 vehicles.

The adverse effects on combustion efficiency, due to decreased air density, may be compensated for in at least six ways:

(1) By an altitude controller air port or valve for admitting more air;

(2) By a variable fuel orifice for restricting fuel flow;

(3) By pressure reduction in the carburetor float chamber for restricting fueld flow;

(4) By throttling the air supply to maintain constant air density;

(5) By a pressure regulated carburetor power metering valve for preventing rich mixtures; and

(6) By a barometrically controlled vacuum spark advance for maintaining mean effective cylinder pressure.

2. Effectiveness of High Altitude Modification

According to estimates made by the Colorado Department of Public Health, emission reductions of 25 percent for carbon monoxide and 15 percent for hydrocarbons can be expected from modifications to 1968-1974 light-duty vehicles. By 1975, vehicles in this classification should approach 50 to 60 percent of total light-duty vehicle registrations.

III. SALT LAKE CITY CONTROL MEASURES

A. CURB PARKING PROHIBITION

1. General

A program of curb parking prohibition has been proposed by The State of Utah in its Implementation Plan. This program would

prohibit all curb parking in the central business district (CBD) during both the 7:00 to 9:30 a.m. and 4:00 to 6:00 p.m. peak traffic periods to increase vehicle speeds and reduce circulating traffic (traffic traveling around the block looking for a parking place). The program should also serve as a stimulus for the use of mass transit and the proposed local shuttle bus service.

The area covered by the curb parking prohibition program covers a 15-block area generally bounded by South Temple on the north, 2nd East, 500 South and West Temple.

Existing parking regulation signs would have to be revised to reflect this prohibition. Enforcement could be provided by City Police in a manner similar to other city parking regulations. Special consideration and exemptions may have to be applied to curb loading zones. Curb lanes normally allocated to parked vehicles could also be utilized for bus lanes to expedite transit movement in the CBD.

2. Effectiveness of Curb Parking Prohibition

Prohibition of curb parking will impact on vehicular travel in two ways. First, it will discourage vehicle travel into the CBD during peak traffic periods. Second, it will eliminate much of the circulating traffic that currently travels around the block looking for a curb parking space.

There are approximately 13,160 curb spaces in the CBD area defined above. Based on average parking turnover rates for cities the size of Salt Lake City, it is estimated that this area can accommodate approximately 57,000 parked vehicles daily. This in effect equals approximately 115,000 vehicle trips per day, see Table C-3.

Table C-3

ESTIMATED PARKING FACTORS

Salt Lake City, Utah

	1973 SPACES	TURN-OVER RATE*	1973 PARKED VEHICLES*	1973 AVERAGE DAILY VEHICLE TRIPS
Meter Curb	1,459	7.1	10,360	41,440
Off-Street	13,157	1.4	18,420	73,680
TOTAL	14,616		28,780	115,120

* Based on 8-hour period; 10:00 A.M. to 6:00 P.M.

Assuming an average trip length of 0.75 miles, approximately one-half of the maximum dimensions of the 15-block area, the total estimated reduction in VMT with no parking 4:00 to 6:00 p.m. is:

1459 curb spaces, assume 65 percent occupied at 4:00 p.m.

1459 x 0.65 = 948 vehicles without available curb parking

Assume 50 percent reduction in vehicle use remainder use off-street parking facilities.

948 x 0.50 = 474 vehicles

474 vehicles x 0.75 miles (average trip length) = 356 VMT reduction

Also assume 5 percent reduction in total traffic (reduction in circulating traffic)

Total VMT 4:00 to 6:00 p.m. = 153,700* x 0.185** = 28,434

Total VMT reduction 4:00 to 6:00 p.m. = 28,434 x 0.05 = 1,421

Therefore, total reduction 4:00 to 6:00 p.m.

$$\frac{356 + 1,421}{153,700 \times 0.185} = 6.3 \text{ percent}$$

Thus, we have assumed an estimated reduction in vehicle emissions of 6 percent in light-duty vehicles in the Salt Lake City CBD.

B. COMPUTERIZED SIGNAL SYSTEM

1. General

This strategy was recommended in the previous Salt Lake City Study and a full discussion is contained in Reference 1.

Basically, the measure calls for the installation of a computerized traffic signal system covering a 300-square-block area

*Total daily VMT in CBD.

**Percent of travel between 4:00 and 6:00 p.m., see Table A-2.

in downtown Salt Lake City. The estimated cost of the proposed signal system is $400,000 with $300,000 coming from Federal TOPICS funds.

2. Effectiveness of Computerized Signal System

In estimating the impact of this strategy, it was assumed that by decreasing traffic idling periods, starts and stops, vehicle speeds will be increased as follows:

	Speeds	
	Existing	Computerized System
4:00 to 6:00 p.m.	15	19
6:00 p.m. to Midnight	19	22

For a full discussion of supporting evidence, see Reference 1, pages III-25 to III-28.

This increase in vehicle speeds results in a decrease in vehicle emission of approximately 8 percent during the 4:00 p.m. to midnight period.

C. MASS TRANSIT IMPROVEMENTS

1. General

Recent efforts of the Utah Transit Authority have resulted in a dramatic increase in revenue passengers since the 1971 low of 3.1 million. This increase, according to the Utah Transit Authority, was caused primarily by better scheduling, an improved public information program, improved bus stops, and the posting of bus schedules at bus stops.

The new trend in transit ridership obviously has a beneficial impact on vehicular emissions in Salt Lake City. Based on 1973 estimates of transit patronages, 3.7 million revenue passengers (1.235 million revenue passengers for the months of January, February, March, and April 1973), there will be an increase of approximately 600,000 revenue passengers over the low of 1971. (See Table C-4.)

Table C-4

REVENUE PASSENGER TRENDS 1971-1973

Utah Transit Authority

	1971	1972	1973
January	266,887	267,231	325,595
February	247,907	266,047	299,603
March	278,312	289,982	315,878
April	269,811	265,540	294,389
May	252,777	275,400	
June	242,020	246,593	
July	226,294	224,664	
August	241,819	259,311	
September	253,362	267,962	
October	266,027	297,077	
November	273,637	296,438	
December	282,482	300,824	
TOTAL	3,101,335	3,257,069	3,700,000*

* Estimate based on experience during the months of January, February, March and April.

Projections for 1975, assuming no significant expansion of transit service by the Utah Transit Authority, could range from 4.0 to 5.0 million revenue passengers, see Figure C-1.

The low estimate assumes a slight increase in transit ridership. The high estimate assumes a continued growth in transit ridership. For the purposes of this analysis, the impact will consider the following levels of transit ridership:

ANNUAL REVENUE PASSENGERS (Millions)

		INCREASE OVER
	1975	1971
High	5.0	1.9
Low	4.0	0.9

2. Effectiveness of Mass Transit Improvements

Without comprehensive vehicular traffic count information, it is difficult to verify the precise impact of the increase in transit ridership on automobile travel. Perhaps some of the new transit passengers were the result of "new trips." It is also possible that some of the new transit patrons were diverted from "car pools" and therefore do not actually represent less automobile travel. However, for the purposes of estimating the impact of the new trend in transit ridership, we have assumed that all of the new transit passengers were diverted from private automobiles, either as auto-drivers or auto-passengers and, therefore, represent a reduction in auto-person trips.

Therefore, 1.9 million annual auto-person trips = 5220 average daily auto-person trips, and

0.9 million annual auto-person trips = 2470 average daily auto-person trips.

Note that for the purpose of this analysis, annual travel has been converted to average annual daily auto-person trips by dividing by 365. This is consistent with previous estimates of average

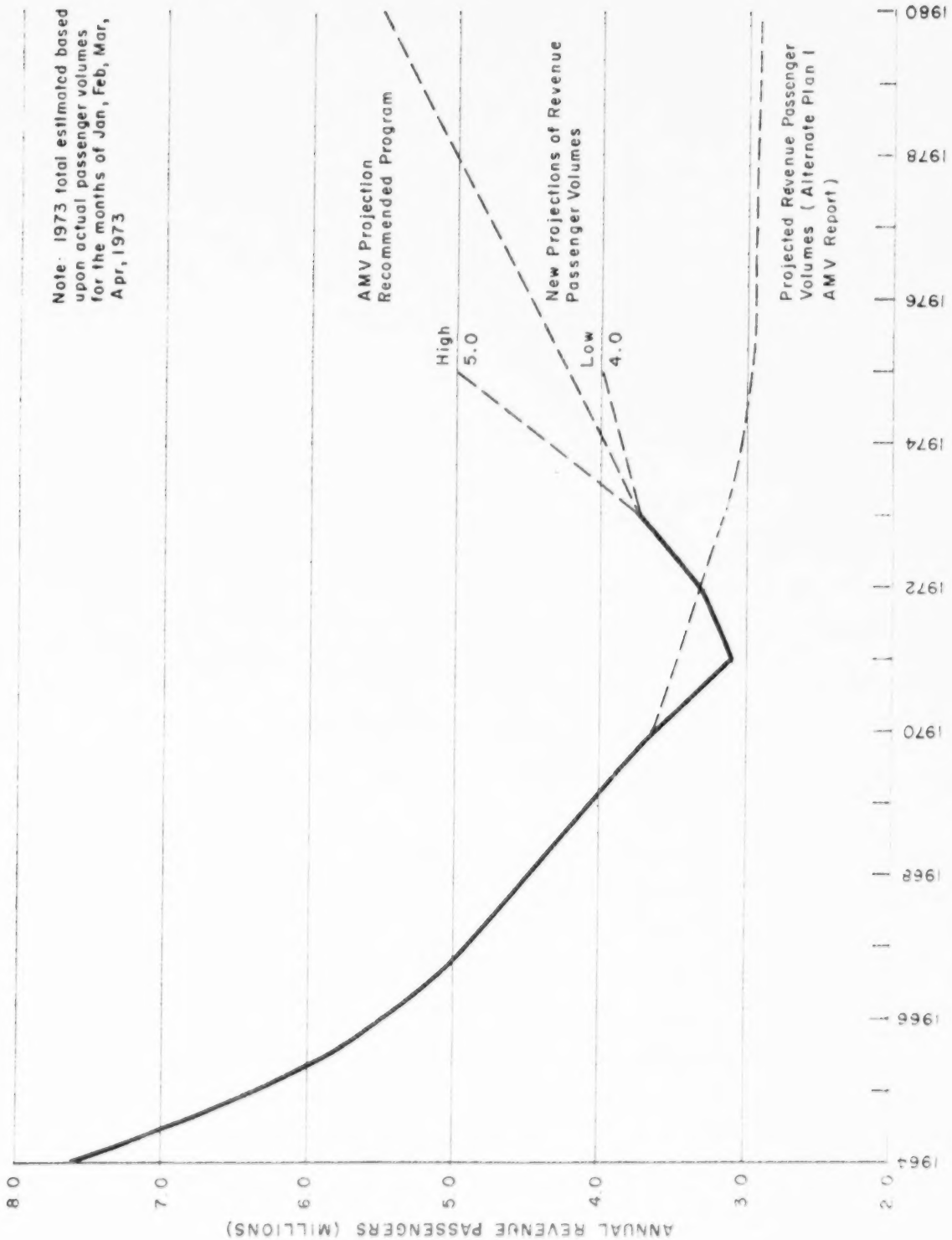

Figure C-1. Revenue passenger volumes 1964-1980, Utah Transit Authority

daily travel (VMT); however, if data were available and time permitted, it would be more accurate to estimate the impact during the time of peak emission concentrations (during the months of November and December). Transit travel, according to the Utah Transit Authority, is significantly higher during these months of the year.

According to the Salt Lake City Area Transportation Study, the average automobile occupancy per vehicle is 1.46. Thus, a reduction of 5,220 average annual daily auto-person trips equals approximately 3,580 daily vehicle trips area-wide.

Due to the higher vehicle densities and concentration of auto and transit travel, the impact of increased transit usage on travel in Sector H would be as shown in Table C-5.

Table C-5

IMPACT OF INCREASED TRANSIT USAGE ON TRAVEL

	REDUCTION IN AAD PERSON-TRIPS		VEHICLE OCCUPANCY FACTOR		AVERAGE TRIP LENGTH		REDUCTION IN DVMT
High	5,220	÷	1.46	x	0.75	=	2,680
Low	2,470	÷	1.46	x	0.75	=	1,270

	1975 DVMT (000)	HIGH REDUCTION IN 1975 DVMT(000)	LOW REDUCTION IN 1975 DVMT(000)	HIGH PERCENT REDUCTION	LOW PERCENT REDUCTION
Sector H	182.3	2.7	1.3	1.5	0.7

The above estimates indicate a reduction in VMT by 1975 of between 0.7 and 1.5 percent, which is somewhat lower than the previous estimate of 2.0 percent by the State of Utah. However, a 2.0 percent reduction was accepted as a reasonable estimate, especially in view of the current plans for expansion of transit service planned by the Wasatch Front Regional Council.

3. Plans for Further Expansion

The Wasatch Front Regional Council has prepared a Recommended Transit Improvement Program with the help of Alan M. Voorhees and Associates, Inc. This program includes recommendations for:

- Expanded Intra-Community Service (local service in Salt Lake City, the Ogden area, the Bountiful area, and Brigham City;
- Inter-city Transit Service between Salt Lake City and Ogden, Salt Lake City and Tooele, and other inter-city service in Salt Lake County;
- Inter-city Express Bus Service between Bountiful and Salt Lake City, and Granger-Hunter-Kearns to Salt Lake City;
- Special Worker Service; and
- A Salt Lake City Downtown Shuttle Bus System.

Plans are presently being finalized for expanded transit service for the Provo area.

Implementation of these recommendations and the expansion of service for Salt Lake City, as recommended in a previous report, prepared by Alan M. Voorhees & Associates, Inc., are a necessary and integral part of any program for improving air quality in the Wasatch Front Region. Transit must become a viable alternative to automobile travel in order to reduce vehicle emissions.

The Wasatch Front Regional Council's current study on transit, which is in draft form and unapproved, contains specific recommendations for transit policies. These policies, if adopted and

implemented, can have a significant impact on vehicular travel and emissions for Salt Lake City. The recommendations include:

- Increase the cost of on-street parking in the CBD core to 10 cents per half-hour and in the CBD fringe to 10 cents per hour.
- Increase the assessed valuation of land used for commercial parking lots to more accurately reflect its true value.
- Institute parking fees at all state, county, and city parking lots.

The implementation of these policies, together with the Salt Lake City Downtown Shuttle service can be expected to have a significant impact on vehicle emissions. In order to achieve and sustain a 2 percent reduction in emission by 1975, it is possible that some of the above transit policies will have to be implemented along with the proposed Downtown Shuttle Bus System.

It should also be emphasized that the Curb Parking Prohibition Control Measure (during peak traffic period) complements the recommended transit policies currently being considered by the Wasatch Front Regional Council. These policies, implemented with the Downtown Shuttle Bus System may produce, in combination, a slightly greater impact on vehicle emission than previously estimated.

IV. PROVO CONTROL MEASURES

A. CENTER STREET PARKING CHANGE

1. General

Center Street in Provo is an important part of the City's circulation system that is now frequently congested. Vehicle operating speeds during peak periods frequently average less than 10 miles per hour, primarily because of the angle parking.

Angle parking is permitted in the center of the street and at the curb. In effect, Center Street is basically a parking lot which

at the same time carries a large volume of through traffic. According to the Provo City TOPICS Plan, the current traffic volume on Center Street exceeds 9,000 vehicles per day.

It is proposed that all angle parking be prohibited on Center Street from 500 West Street to 100 East Street. Parallel parking may be permitted at the curb.

Prohibition of angle parking will permit two lanes of traffic in each direction with provisions for left-turn lanes at intersections, as needed. It is estimated that prohibition of angle parking will greatly increase vehicle speeds on this portion of Center Street, thereby reducing congestion, vehicle stops, and delays.

It should be mentioned that the City of Provo has discussed alternate plans for traffice on Center Street. These alternate plans include possible one-way streets and a mall for Center Street. A one-way street plan could accomplish the desired result if designed properly, and should be considered as an acceptable alternative.

2. Effectiveness of Parking Change

The effect of prohibiting angle parking on Center Street will be principally to increase vehicle speeds, and therefore, reduced emissions. It is also possible that vehicle traffic may increase slightly as a result of increased speed. If this does occur, it is assumed that this would merely be a shift in traffic from adjacent streets (100 North and 100 South) and not a general increase in travel in the CBD.

It is estimated that prohibition of angle parking will increase average vehicle speeds from 10 to 15 miles per hour. This results in a reduction in vehicle emissions of 370 kg/8 hr/mi^2.

B. MASS TRANSIT IMPROVEMENTS

At present, there are no completed approved plans for expansion of transit service in Provo. Existing transit service basically connects the CBD with the Brigham Young University and residential areas, south of the campus, with the CBD.

It is expected that the current transit planning study by the Wasatch Front Regional Council will contain specific recommendations for improving and expanding transit service.

Without specific plans and schedules, it is difficult to estimate the impact of improved transit service. It is assumed that the impact on vehicle travel by 1975 will be a reduction of approximately 2 percent, based on calculations in Salt Lake City.

V. OGDEN CONTROL MEASURES

A. BY-PASS TRAFFIC, I-80N

1. General

At present, I-80N is nearing completion and will be opened to traffic by 1974. This will complete a by-pass route around the southern part of the City of Ogden which will, in effect, reduce traffic in the CBD, especially on Washington Boulevard.

2. Effectiveness of the By-Pass

It is expected that the opening of I-80N will eliminate all through traffic and some local traffic from Washington Boulevard. It is estimated that the impact on vehicular travel in zone O-1 will be a reduction in the order of 1.5 percent in 1975. Basically, this means a reduction in VMT from 141,700 to 134,715 vehicle-miles daily. This equals approximately 7,000 vehicles per day which is somewhat less than the total projected traffic for I-80N and, therefore, is a reasonable estimate of the impact of this facility.

This reduction of traffic in the CBD by this amount will also tend to increase vehicle speeds somewhat. This effect was not calculated since it was considered to be small and therefore insignificant.

B. MASS TRANSIT IMPROVEMENTS

The latest plans for transit improvements for Ogden are contained in the Wasatch Front Transit Study prepared by Allan M. Voorhees and Associates. This report proposes the addition of four new radial transit lines extending from 24th and Washington Boulevard, plus additional inter-city service. The report also proposes an increase in curb parking rates from 5 cents per hour to 10 and 20 cents per hour; adjustments in land assessment practices in the downtown area to reflect the fact that parking lots are much more than merely vacant land and a transit validation system. Based on these recommendations, the report estimates 1974 daily transit passenger volumes in the range of 869,000.

The report also estimates a 2.5 percent reduction in VMT in Weber County by 1976 with implementation of the above transit improvements. Therefore, a 2 percent reduction appears to be a reasonable estimate for 1975. Perhaps, with the concentration of transit travel in the CBD (zone 0-1), the reduction could in fact be slightly greater.

APPENDIX D

MONITORING AND SURVEILLANCE

A monitoring and surveillance system is necessary to judge the success of the Federal Motor Vehicle Control Program and the selected control measures contained in this document since there are a number of uncertainties which could cause the actual emission levels to vary from the estimates. The proposed monitoring and surveillance system should be carried out on three levels, each of which is discussed briefly below.

1. Review Progress in Implementing Selected Control Measures

To be fully effective by May 31, 1975 it is necessary that action begin immediately to implement the selected control measures. It is particularly important that the availability of the two retrofit devices be fully investigated so that the need for alternate control measures, such as those proposed in Appendix E, can be determined. Provision must be made for the training of an adequate number of certified inspection and maintenance crews to process all light-duty vehicles registered in Davis, Salt Lake, Utah, and Weber Counties within a six-month period beginning January 1, 1975. Because of the short period of time available, the early establishment of an implementation schedule covering all aspects of the control measures and frequent progress checks are critical to the success of the program.

2. Monitor the Impact of Selected Control Measures on Traffic Flow

The two traffic parameters which should be measured to verify the success of the selected control measures are:

. Traffic volumes (ADT and hourly volumes) and,

. Average operation speeds.

a) Traffic Volume Surveillance

Current traffic counting programs by the Utah State Department of Highways and the cities and counties should be continued to provide the data base for calculating vehicle travel. The Department of Highways annually makes estimates of travel by type of facility and by county; however these estimates do not cover urban streets and are not adequate. Therefore a systematic method of calculating VMT by vehicle type, road class and speed for the designated zones and sectors should be established.

The existing count program should be expanded to provide greater coverage in the CBD's of Salt Lake City, Ogden and Provo.

Tables A-1, A-5 and A-9 of Appendix A present the existing and projected daily VMT's for the designated zones. In general the projected travel estimates were based upon State Department of Highways projections, and reflect the following traffic growth rates:

Salt Lake City - 3 percent annual increase

Provo - 4 percent annual increase

Ogden - 6 percent annual increase

The above increases assume no impact on vehicular travel of other control measures; therefore the actual growth rate should be somewhat less depending upon the actual impact. Regardless, the VMT estimates contained herein provide the benchmark for evaluating the impact of the selected control measures.

Although it is possible to estimate VMT's based on existing data, it is recommended that the existing traffic count program be expanded to

1. Provide complete ADT counts in the three designated zones;
2. Spot vehicle classification counts to provide verification on vehicle travel by type of vehicle (light duty, heavy duty and diesel).

b) Speed Surveillance

Average operating speeds by type of street and time of day represent the most critical data deficiency at present. Current speed and travel studies are almost entirely restricted to arterial streets or state highways. Comprehensive travel time surveys should be conducted immediately on all streets in the three designated zones to verify the current estimates and to provide a base for comparing future impacts resulting from implementation control measures, especially the computerized traffic signal system in Salt Lake City and the angle parking prohibition in Provo.

3. Monitor Air Quality

The combined effectiveness of the FMVCP and other control measures that may be implemented in reducing ambient carbon monoxide concentrations ultimately must be judged by air quality measurements. Monitoring stations in the three cities are currently located within the areas which are of principal concern and subject to the full impact of the control strategies. The monitors can, therefore, provide the necessary measurements by which the success of the control program can

be evaluated.

The curves shown in Figures H-1, H-2, and H-3 provide some guidance as to the second-highest, 8-hour concentrations to be expected within the three CBD's through 1982. It must be remembered, however, that the actual observations will show considerable scatter about the predicted curves as a result of year-to-year variations in meteorological and other controlling factors.

APPENDIX E

ALTERNATE CONTROL MEASURES

Based upon recent evaluations by EPA, it appears that it may be impossible, because of various problems, to fully implement the air bleed to intake manifold and high altitude retrofit prior to June 30, 1976. Because of this finding, EPA has proposed alternate control measures which can be implemented more rapidly, so that the reductions necessary to achieve the air quality standards by May 31, 1975 can be obtained. Of necessity, the measures selected impose additional restrictions on auto travel in the area. The three alternate control measures which have been proposed are discussed below.

1. Gasoline Limitations

This measure limits the amount of gasoline which can be supplied to retail gasoline outlets in the counties of Davis, Salt Lake, Utah and Weber during control years to the total gallonage delivered during the 12-month period from July 1, 1972 to June 30, 1973 (the base year). In principle, this measure would reduce the availability of gasoline for automobile travel in the region to a level which would accommodate current VMT only.

The true impact of this proposed gasoline limitation program is difficult to estimate. However, it is reasonable to assume that the restricted supply of gasoline will permit only minor increases in VMT by 1975. Thus the expected reduction in VMT, over previous estimates assuming normal growth, would be in the range of 6 to 12 percent

by 1975, as can be seen from Table E-1, and would vary from city to city. Once the program has been established, its impact can be increased or decreased merely by adjusting the supply of gasoline.

2. Bus/Carpool Lanes

Bus/carpool lanes are proposed as an alternate control measure for Davis, Salt Lake, Utah and Weber Counties. These bus/carpool lanes would be required on all major streets and highways with three or more traffic lanes in one direction. The requirements are as follows:

a) Four or more traffic lanes - One lane reserved for buses or carpools at all times with a second lane reserved for buses (or buses and carpools) from 6:30 AM to 9:30 AM and from 3:30 PM to 6:30 PM.

b) Three traffic lanes - One lane reserved for buses or carpools from 6:30 AM to 9:30 AM and from 3:30 PM to 6:30 PM.

The effect of this measure is two fold. On the one hand, it provides an exclusive lane for bus and carpool vehicles, thereby giving them an advantage over other travel. On the other hand, it reduces the number of lanes for normal traffic and may therefore increase congestion and delay within these lanes unless the desired shift toward the use of carpools and buses is substantial. The impact of this control measure is extremely difficult to predict. Many motorists may find attractive alternate routes for travel in the control areas. Also, except for express buses, the transit speed of buses is controlled to a very large extent by the number and duration of transit stops and not exclusively by traffic delays. For this reason, it

TABLE E-1

NORMAL TRAFFIC GROWTH RATE

(percent)

City	Annual Rate	Projected Increase To June 1, 1975
Salt Lake City	3	6
Provo	4	8
Ogden	6	12

may be operationally unwise to combine bus and carpool lanes on certain streets or at certain times of day. An accurate assessment of the impact or effectiveness of this control measure can be made only after an in-depth study of specific routes.

Prior to implementation, a thorough analysis should be made of each specific major street or highway affected by the regulation. The study should investigate the existing volume to capacity relationship, alternate routes available for auto travel, specific accident problems, and other traffic operation and enforcement problems.

It is important to note that the measure as proposed has great flexibility and can be adjusted later to obtain the desired impact. Either additional travel lanes can be reserved for transit and carpool vehicles, or lanes can revert back to normal automobile travel. Also, the areas covered by the measure can be expanded to include other streets or can be contracted to cover only specific problem areas.

3. Management of Parking Supply

This measure would prohibit the construction of any new parking facility or modification or enlargement of any existing parking facility unless approval is granted by the Administrator, or an agency approved by the Administrator, stating that the proposed action will not interfere with the attainment or maintenance of applicable Federal air quality standards. A regulation to this effect would provide a means for controlling the overall supply of parking spaces and its future distribution within Davis, Salt Lake, Utah and Weber counties.

APPENDIX F

MONTHLY SUMMARIES OF CARBON MONOXIDE CONCENTRATIONS

Tables F-1, F-2, and F-3 list the three highest 8-hour carbon monoxide concentrations observed each month in Salt Lake City, Ogden, and Provo, respectively, since the establishment of the monitoring stations, through December 1972. The tables also contain the number of 8-hour averages that were greater than the national standard of 9 ppm each month. The 8-hour concentrations used in these tabulations are based on a running mean concentration made up of eight 1-hour averages. Consequently, the three highest 8-hour concentrations reported in a month very frequently are observed during a single 3-hour period and do not represent independent events.

TABLE F-1

LISTING OF THREE HIGHEST 8-HOUR CO CONCENTRATIONS
IN SALT LAKE CITY BY MONTH AND TIME OF OCCURENCE

1970

MONTH	CONC. (ppm)	DAY	HOUR	NO. > 9ppm
Jan.	15.5	22	24	73
	15.1	13;22	02;23	
	14.9	13;23	01;14	
Feb.	22.3	7	03	124
	21.6	7	04	
	20.8	7	02	
Mar.	8.1	7	06	0
	8.0	7	07	
	7.9	7	05	
Apr.	No Data			
May	10.0	24	24	22
	9.9	24;25	22,23;02,03,10	
	9.8	24;25	21;04,09	
June	14.6	19	24	67
	14.4	20	01	
	14.0	8;20	24;02	
July	12.5	2	04,05	16
	12.1	2;4	06;04	
	11.8	2;4	03;05	
Aug.	9.4	12	01	2
	9.3	12	02	
	9.0	12	03	
Sept.	10.5	23	12	14
	10.4	23	11	
	10.3	23	09,10,13	
Oct.	22.6	31	03	74
	22.1	31	04	
	22.0	31	02	
Nov.	19.6	1	05	62
	19.5	1	06	
	19.3	1	04	
Dec.	17.9	14	10	155
	17.0	14	9	
	16.6	14	8	
				609

TABLE F-1 (cont)

LISTING OF THREE HIGHEST 8-HOUR CO CONCENTRATIONS
IN SALT LAKE CITY BY MONTH AND TIME OF OCCURENCE

1971

MONTH	CONC. (ppm)	DAY	HOUR	NO. > 9ppm
Jan.	20.0	28	03	64
	19.6	28	04	
	19.4	28	02	
Feb.	No Data			
Mar.	9.5	30	03	6
	9.4	28;30	05,06;02	
	9.1	30	04	
Apr.	11.3	28	14,15	25
	11.1	28	11,12,13	
	11.0	28	10	
May	15.3	11	24	27
	15.1	11;12	23;01	
	14.4	11;12	22;02	
June	11.0	16	05	13
	10.6	16	04	
	10.5	23	04	
July	9.8	14	05	4
	9.6	14	04	
	9.1	14	03	
Aug.	12.0	25	15	7
	11.8	25	14	
	11.4	25	13	
Sept.	10.4	12	04	11
	10.3	12	03	
	9.9	12;30	05;23	
Oct.	13.1	21	02,03	46
	12.6	21	04	
	12.5	22	03	
Nov.	23.5	4	02	84
	23.3	4	03	
	21.9	4	01	
Dec.	17.4	17	21	40
	16.9	17	22	
	16.8	23	23	
				327

TABLE F-1 (cont)

LISTING OF THREE HIGHEST 8-HOUR CO CONCENTRATIONS
IN SALT LAKE CITY BY MONTH AND TIME OF OCCURENCE

1972

MONTH	CONC. (ppm)	DAY	HOUR	NO. > 9ppm
Jan.	14.0	7	10	30
	13.6	7	09	
	13.0	7	11	
Feb.	14.1	24	10	22
	13.8	24	11	
	13.4	24	9	
Mar.	10.4	9	03,04	6
	9.9	9	02,05	
	9.6	9	01	
Apr.	10.5	29	03	4
	10.3	29	04	
	9.9	29	02	
May	8.9	31	23	0
	8.8	31	24	
	8.5	31	22	
June	9.4	1	14	2
	9.1	1	13	
	9.0	1	15	
July	16.8	8	05	16
	16.6	8	04	
	16.5	8	06,07	
Aug.	11.6	9	04,05	6
	11.1	9	03	
	10.6	9	06	
Sept.	8.8	14	09	0
	8.6	14	10	
	8.5	15	09	
Oct.	13.0	3	11	57
	12.9	3	09,10,12	
	12.8	2	09	
Nov.	20.6	10	03	67
	20.1	10	02	
	19.9	9;10	01;02	
Dec.	40.9	2	03	207
	40.8	2	02	
	37.5	2	01	
				417

TABLE F-2

LISTING OF THREE HIGHEST 8-HOUR CO CONCENTRATIONS
IN OGDEN BY MONTH AND TIME OF OCCURENCE

1971

MONTH	CONC. (ppm)	DAY	HOUR	NO. > 9ppm
Jan.	No Data			
Feb.	18.4	8	22	64
	18.1	8	23	
	17.8	8	24	
Mar.	9.6	21	04	2
	9.3	21	03	
	8.1	21	02	
Apr.	12.8	3	01	11
	12.3	3	02	
	11.8	2;3	24;03	
May	8.4	2;3	24;01	0
	8.1	25	23	
	8.0	25	24	
June	8.3	22	02,03	0
	8.1	22	01	
	8.0	21;22	02,24;04	
July	7.8	18	01	0
	7.6	18	02,03,04	
	7.5	14	02,03	
Aug.	10.0	27	03	8
	9.9	27	02	
	9.6	21;27	03;04	
Sept.	15.0	24	04	14
	12.3	24	05	
	11.1	14	01	
Oct.	15.3	10	03	55
	15.0	10	02	
	14.3	10	01	
Nov.	16.6	24;25	24;01	59
	16.4	24	23	
	15.6	25	02	
Dec.	15.5	24	19	68
	15.4	23	23,24	
	15.0	23	22	
				281

TABLE F-2 (cont)

LISTING OF THREE HIGHEST 8-HOUR CO CONCENTRATIONS
IN OGDEN BY MONTH AND TIME OF OCCURENCE

1972

MONTH	CONC. (ppm)	DAY	HOUR	NO. >9ppm
Jan.	13.9	22	24	22
	13.5	22	23	
	13.4	23	01	
Feb.	13.9	13	04	34
	13.8	13	03	
	13.0	13	02,05	
Mar.	10.5	18	03	8
	10.3	18	02	
	10.1	18	04	
Apr.	8.4	4	02	0
	8.3	4	03	
	8.1	4	01	
May	7.6	22	24	0
	7.5	23	01	
	7.4	23	02	
June	8.1	30	03,04	0
	7.9	30	02,05	
	7.5	20	24	
July	7.9	5	03,04	0
	7.8	5	02,05	
	7.6	5	01	
Aug.	7.9	10	03	0
	7.8	10	04	
	7.6	10	02	
Sept.	11.8	16	03	17
	11.4	16	04	
	11.3	16	02	
Oct.	13.3	14	03	32
	12.9	14	02	
	12.3	14	04	
Nov.	14.1	4	01	29
	14.0	4	02	
	13.5	4	24,03	
Dec.	33.9	20	23	124
	33.6	20	24	
	32.8	21	01	
				266

TABLE F-3

LISTING OF THREE HIGHEST 8-HOUR CO CONCENTRATIONS
IN PROVO BY MONTH AND TIME OF OCCURENCE

1970

MONTH	CONC. (ppm)	DAY	HOUR	NO. > 9ppm
Jan.	9.1	13;23	02,03;01,02	4
	8.8	21;22	04,05;24	
	8.6	16;22	02;23	
Feb.	8.9	18	06	0
	8.8	18	05	
	8.5	18	07	
Mar.	5.6	19	24	0
	5.5	20;24	01;04	
	5.4	24	03,06,07	
Apr.	3.8	20	09	0
	3.6	20	08,10	
	3.4	20	07,11	
May	6.4	28	09,10	0
	6.3	28	11	
	6.0	28	08	
June	6.8	10	20,21	0
	6.6	10	18,19,22	
	6.5	10	17,23	
July	7.5	13	05	0
	7.4	13	06	
	7.3	13	04	
Aug.	6.1	8	05,06	0
	6.0	10;28	10;12	
	5.9	10;28	11;11,13	
Sept.	7.6	18	04	0
	7.3	18	05	
	7.1	18	03	
Oct.	No Data			
Nov.	8.8	24	01,02	0
	8.6	15	02,03	
	8.4	24	03	
Dec.	12.6	4	01	14
	12.1	4	02	
	12.0	3	24	
				18

TABLE F-3 (cont)

LISTING OF THREE HIGHEST 8-HOUR CO CONCENTRATIONS
IN PROVO BY MONTH AND TIME OF OCCURENCE

1971

MONTH	CONC. (ppm)	DAY	HOUR	NO. > 9ppm
Jan.	20.0	31	06	43
	16.6	30;31	03;07	
	16.4	30	02	
Feb.	7.5	2	02	0
	7.0	1	13,14	
	6.9	1; 2	15;01	
Mar.	8.5	20	04	0
	8.0	20	03	
	7.9	20	05	
Apr.	5.8	23;25	02,03;03,04	0
	5.6	23;25	04;01,02	
	5.5	23;25	05;05	
May	15.0	24	09	2
	14.5	24	08	
	6.5	15	02,03	
June	7.3	18	12	0
	7.1	18	11	
	7.0	18	09,11,13	
July	4.8	31	24	0
	4.6	16	04	
	4.5	16;29;31	03;04;12,13	
Aug.	7.0	25	15	0
	6.9	25	16	
	6.8	25	14,17	
Sept.	9.1	24	03	1
	9.0	24	04,13,14	
	8.9	24	15	
Oct.	11.6	23	02	9
	11.4	23	04	
	11.3	23	01	
Nov.	11.6	11	23,24	36
	11.4	11;24	22;03,04	
	11.1	24	01	
Dec.	20.9	20	24	24
	20.5	21	01	
	20.3	20	23	
				115

TABLE F-3 (cont)

LISTING OF THREE HIGHEST 8-HOUR CO CONCENTRATIONS
IN PROVO BY MONTH AND TIME OF OCCURRENCE

1972

MONTH	CONC. (ppm)	DAY	HOUR	NO. > 9ppm
Jan.	16.4	8	04	13
	16.0	8	03	
	15.6	8	05	
Feb.	15.9	5	01	20
	15.3	4	24	
	14.9	5	02	
Mar.	6.3	9;10	24;01,02	0
	6.1	6;9	02;02,03,04	
	5.8	9	01	
Apr.	5.1	1	03	0
	4.9	3	04	
	4.6	1;3	01;03,05	
May	4.9	5	01	0
	4.8	4	24	
	4.6	5	02	
June	4.0	28	11,12	0
	3.9	28	10,13,14	
	3.8	8;28	01;15	
July	4.9	27;29	03,04,05;01,02,03	0
	4.8	27;29	02;04	
	4.6	27	09	
Aug.	8.4	10	01	0
	8.3	10	02	
	8.1	10	03	
Sept.	7.8	20;30	09;24	0
	7.6	26	08	
	7.4	16	03	
Oct.	10.1	1	03	8
	9.6	1	02	
	9.5	1	04,03	
Nov.	12.9	4	03	8
	12.8	4	02	
	12.3	4	01	
Dec.	17.9	2	01	53
	16.6	2	02	
	16.4	2	03	
				102

APPENDIX G

CARBON MONOXIDE EMISSIONS BY MAJOR POINT SOURCES AND BY SOURCE CATEGORIES

Table G-1 lists the major point sources of carbon monoxide emission in Salt Lake, Utah, and Weber counties in 1970 and 1972. Table G-2 contains 1970 estimates of the total carbon monoxide emissions in each county by source category.

TABLE G-1

MAJOR POINT SOURCES OF CO EMISSIONS

Company	Emission (Tons/Year) 1970	1972	Location Bearing/distance from monitor (1)
Salt Lake County			
May Foundry	225	195	328°/2 miles
Kennecott Copper Corp.	87	76	263°/14 miles
LDS Church, Welfare Square	49 (3)	10	265°/1.6 miles
American Oil Company	37	37	332°/.3 miles
Kaibab Lumber*	33	12	190°/8.5 miles
Granite Mill & Fixture	31	3	320°/1.6 miles
Murray City Power	27	3	194°/5.8 miles
Pippy Foundry	16	16	322°/2 miles
* This company closed its Salt Lake Country facility during CY 72; thus, its emission is now zero.			
Utah County			
Backman Foundry and Machine	175 (4)	.09	214°/.6 miles
U.S. Steel Corp., Geneva Plant	Not available		319°/7.5 miles
Pacific States Cast Iron Pipe Co.	9120	8,400	163°/6.2 miles
Spanish Fork Foundry	217	110	177°/7.1 miles
Utah Power & Light, Hale Plant	3	9	358°/5.5 miles
Brigham Young University	30	30	37°/1.2 miles
Provo City Power	8	7	154°/.2 miles
Weber County			
Defense Depot Ogden	16	20	334°/3 miles
Weber County Municipal Incinerator	300 (2)	352	268°/.9 miles

Note: (1) Bearings were measured from true north.

(2) The 1970 CO emissions from the Weber County Incinerator were adjusted to be in accord with the 1972 emissions factor; the 1970 factor was 1 lb/ton of refuse burned and the 1972 factor was 35 lbs/ton of refuse burned.

(3) Reduction of this source does not appear to be real, but rather is a result of a change in emission factors listed in AP-42.

(4) The process used for melting iron was changed resulting in the lower emission.

TABLE G-2

CO EMISSION ESTIMATES FOR THREE COUNTIES IN 1970

	EMISSIONS (tons/year)		
	Salt Lake County	Utah County	Weber County
I. Fuel Combustion (Stationary Sources)			
A. Residential & Commercial	430	256	122
B. Institutions	29	28	6
C. Industrial	152	18	1
D. Elec. Power Generation	60	19	--
SUBTOTAL	(691)	(321)	(129)
II. Process Losses (Point (Sources Only)			
A. Chemical	---	---	---
B. Food & Agricultural	---	---	---
C. Metallurgical	241	10,732	9
D. Mineral Product	---	---	---
E. Petroleum & Petrochem	34	---	---
F. Wood Process	33	---	---
G. Others	---	---	---
SUBTOTAL	(308)	(10,723	(9)
III. Solid Waste			
A. Incineration			
Area	688	190	174
Municipal (Point)	Negligible	---	32
B. Open Burning			
Area	357	274	267
Point	---	---	1,384
C. Agricultural Burning			
Area	204	157	146
SUBTOTAL	(1,249)	(621)	(2,003)
IV. Transportation			
A. Autos & Light Trucks	217,278	71,245	52,089
B. Diesel On Highway	1,493	892	439
SUBTOTAL	(218,771)	(72,137)	(52,528)
C. Diesel Off Highway	1,992	657	611
D. Aircraft	2,885	252	310
E. Railroads	234	251	121
SUBTOTAL	(5,111)	(1,160)	(1,042)
Total (Non-Vehicular)	7,339	12,825	3,183
	(3.2%)	(15.1%)	(5.7%)
Grand Total	226,110	84,962	55,711

APPENDIX H

ESTIMATED CARBON MONOXIDE EMISSION DENSITIES THROUGH 1982

Figure H-1 shows estimates of carbon monoxide emission density for zone H of the Central Business District of Salt Lake City, based on the federal motor vehicle emission control program only and a normal growth rate, from 1970 to 1982. This curve shows that emissions (and consequently ambient concentrations) are expected to fall to allowable levels by December of 1980 as a result of the FMVCP alone. Figure H-1 contains two additional curves for the period from May 31, 1975 to December 31, 1979. These curves show the expected emission densities if the proposed strategies are implemented (curve A), and the expected emission densities if the proposed strategies are implemented except that inspection and maintenance is required only once a year (curve B). These estimates do not include the effects of the alternate strategies discussed in Appendix E. The scales at the right of the figures may be used to estimate the second-highest, 8-hour carbon monoxide concentration to be expected in each one-year period.

Figures H-2 and H-3 present similar information for Provo and Ogden, respectively.

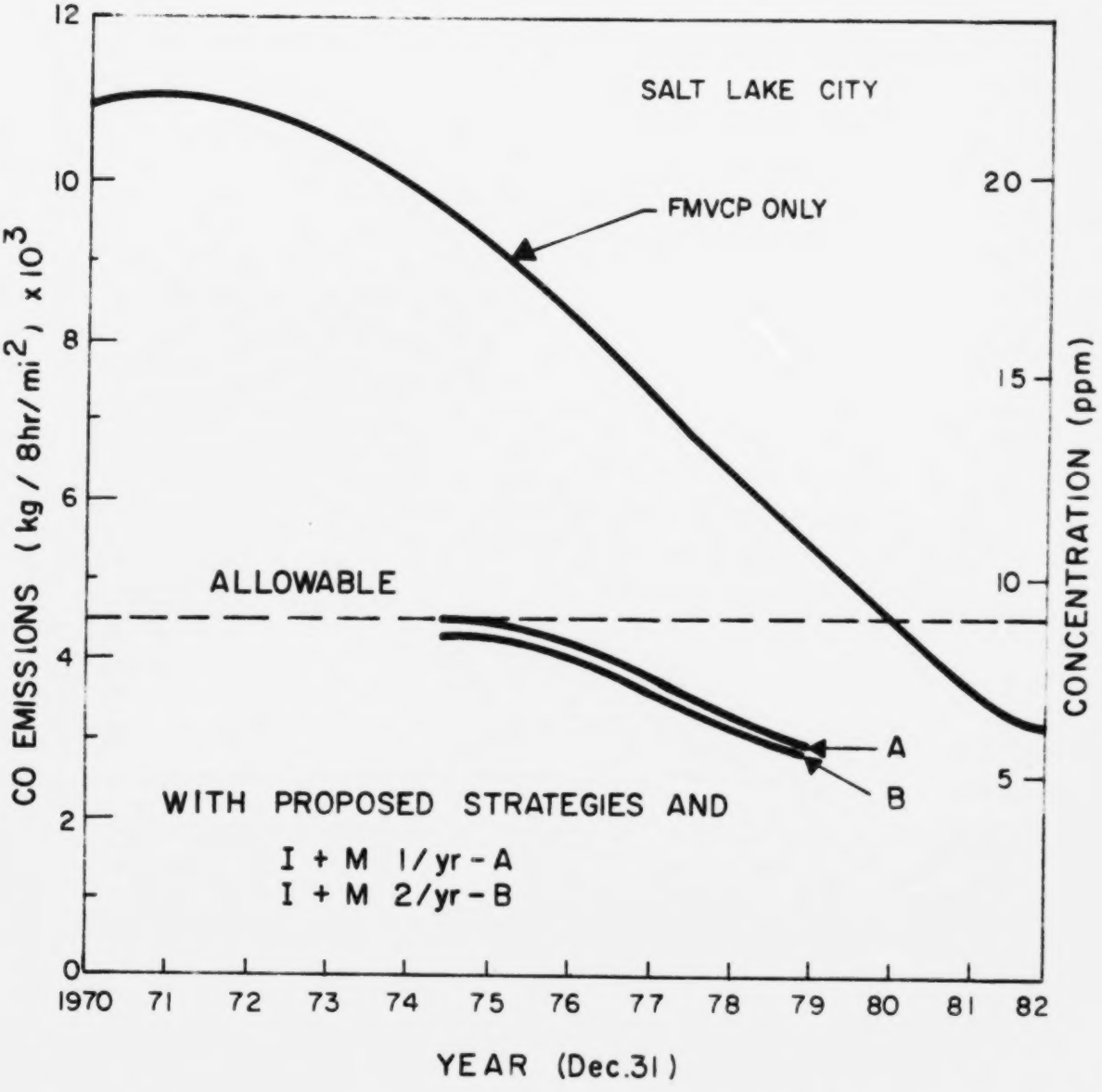

Figure H-1. CO emission densities for Salt Lake City CBD with and without transportation control strategies.

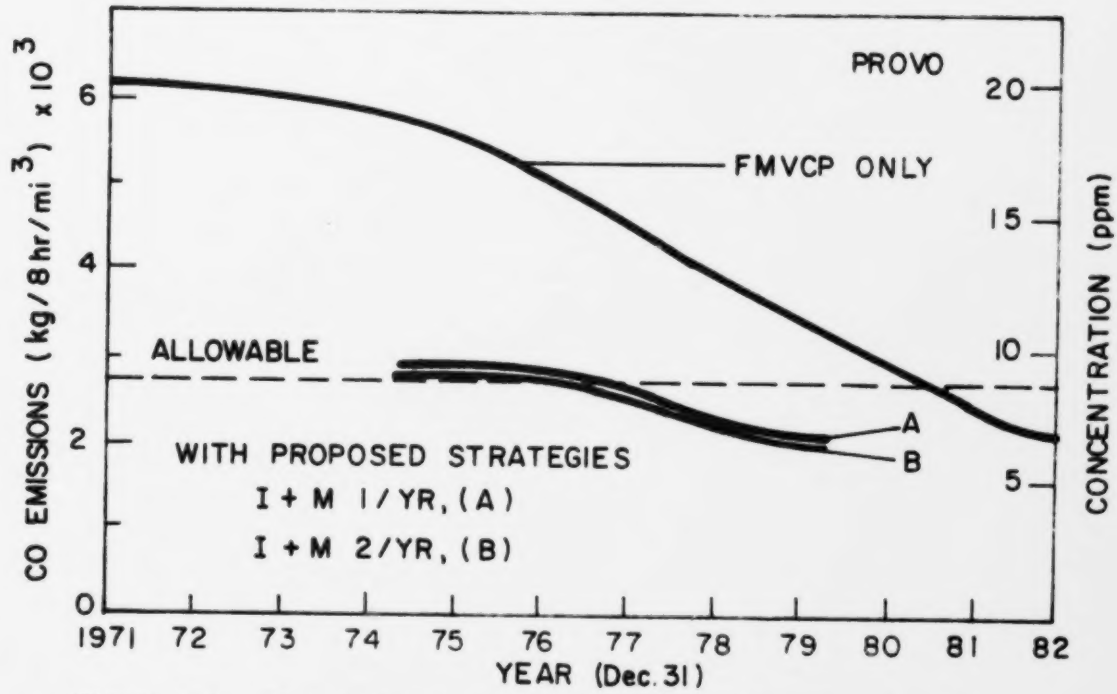

Figure H-2. CO emission densities for Provo CBD with and without transportation control strategies.

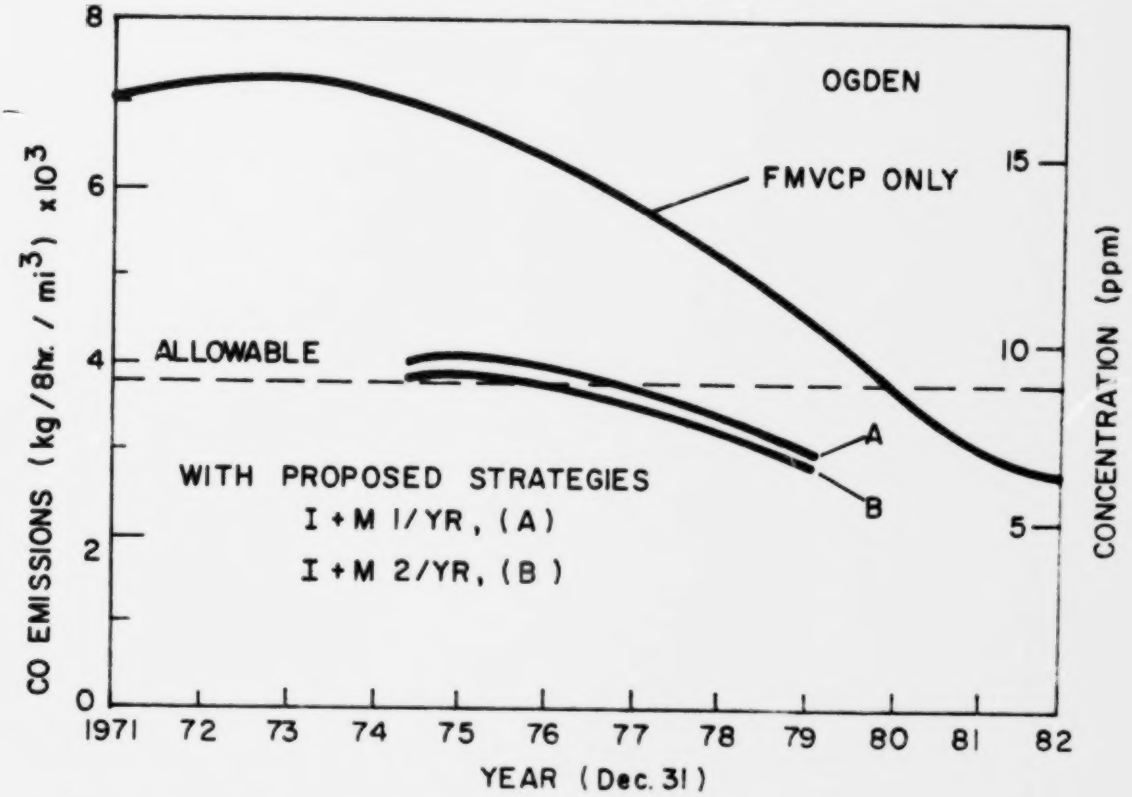

Figure H-3. CO emission densities for Ogden CBD with and without transportation control strategies.